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IN THE ELEVEN WESTERN STATES

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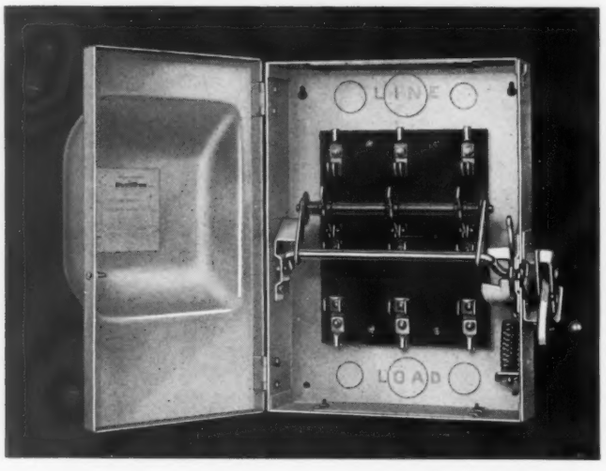

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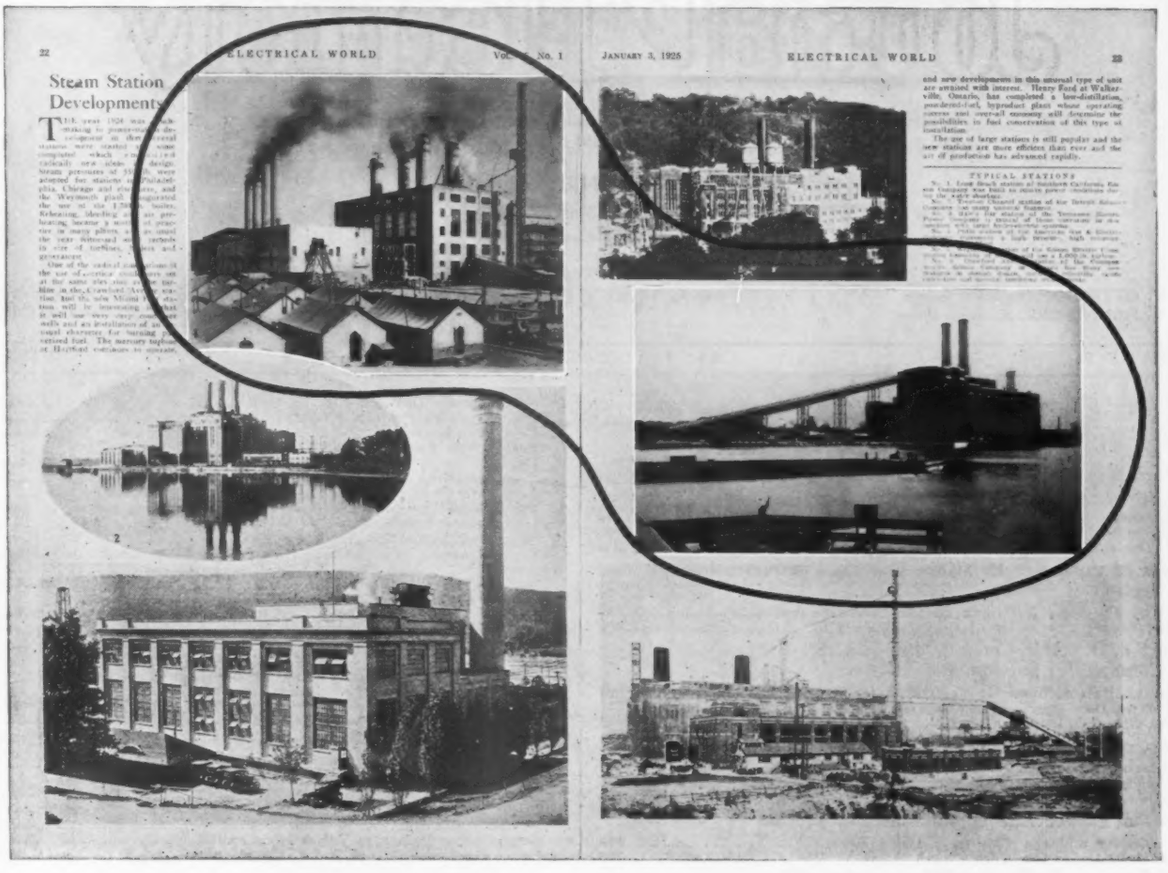

ONE-THIRD of the most notable power station work of last year as selected by ELECTRICAL WORLD was Stone & Webster work. Their selection includes the Weymouth Station at Boston on the Atlantic Coast (right center) and the Long Beach Station at Los Angeles on the Pacific Coast (upper left).

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EDITORIAL

Committee Reports of the Pacific Coast Electrical Association

THIS issue of the Journal of Electricity contains what ordinarily would be the convention papers of the Pacific Coast Electrical Association, in accordance with its usual custom instituted several years ago. Since, however, the National Electric Light Association holds its annual convention in San Francisco, that of the Pacific Coast Electrical Association will consist of no more than a brief business session for the purpose of electing officers and for the transaction of routine business. Thus the only convention that the Pacific Coast Electrical Association will hold for 1925 will be within the covers of this and, we hope, succeeding issues of the Journal.

ALL in all, the papers prepared by the various committees this year represent the finest effort that has yet been made in the annals of the Pacific Coast Electrical Association. The mere fact that there are to be no formal meetings at which these papers will be presented does not detract in the least from their interest and value. On the contrary, it behooves every member of the Association to devote as much time as possible to the study of these papers after the rush and bustle of the N.E.L.A. convention is over; then, having studied and digested the reports of the various committees, written discussion should be prepared and sent to the secretary for publication in the annual proceedings. Lacking the benefit of oral discussion, there will be something gained at least through the careful study and the thought that is required to prepare a written discussion or criticism of the papers.

IT is to be hoped that all of the members of the Pacific Coast Association will study carefully the papers presented in this issue and submit written discussions within the scope of the papers in which the different members personally are interested and informed. A little effort on the part of the P.C.E.A. members can make the 1924-1925 fiscal year stand out as one of real accomplishment in the history of the Association.

FORTY-FIVE hundred delegates are expected to register for the Forty-eighth Convention of the National Electric Light Association to be held in the Exposition Auditorium, San Francisco, June 15-19. San Francisco's municipal auditorium, built during the Panama Pacific Exposition in 1915, is an ideal building for holding a convention of this nature. The main hall will seat more than 10,000 people.

Increasing the Use of Electrical Appliances

Report of Appliance Bureau, Commercial Section.*

THE plan of work of the appliance bureau for the year 1924-1925 was concisely stated by T. W. Berger, chairman of the appliance committee of the National Electric Light Association, in his letter outlining the national committee's plans. First, to produce data now available and make new studies to show the value of the household appliance load; second, to recommend definite selling plans for various appliances, outlining in detail each step necessary to conduct a successful campaign.

At the first meeting of the appliance bureau it was decided to conform the year's work to the second recommendation, as other agencies were already engaged in the survey recommended in the first suggestion. Toward this end two papers have been prepared and are presented as part of this report. The papers are: "A Suggested Merchandising Plan for Central Stations," by A. L. Spring and H. C. Rice, and "Dealer's Plan for Selling Small Appliances," by D. D. MacFarlane and J. T. Deppe.

We believe that the practical thoughts and suggestions embodied in these articles cannot fail to improve appliance sales provided they are actually followed by the central station and dealer. It is unfortunately true that more able committees of the past have also presented admirable working plans to which a small degree of attention has been paid by the industry. Recommendations only, without the necessary tools of putting them in actual operation, mean a very small percentage of realization on an appliance bureau's year's work.

It is the appliance bureau's recommendation to the members of the Pacific Coast Electrical Association that very serious thought be given to the tying in of the Bureau's work with the actual operation of selling plans, modified to suit local conditions, administered by a salaried representative. It may be feasible to associate the bureau work with that of some already organized branch of the electrical industry on the Pacific Coast. Possibly a reorganization or a combination of the present paid branches could be effected. The appliance bureau considers that unless some practical method is devised for following up recommendations that the greater part of the year's work is lost.

One of the proposed activities for the current year was the adoption of a special percolator campaign plan. The subcommittee appointed for that purpose found too varying opinions as to the best methods to be able to recommend a complete selling plan at the time of this report. Certain plans and methods are now being tried and the subcommittee is planning to turn over to its successor some practical experience which may be embodied in next year's actual operations.

One of the outstanding observations of this year's work is the increasing indifference on the part of the great number of electrical contractor-dealers to the further development of electrical merchandise sales, and to the absorption of this business by the specialty dealers and department stores. The absence from this field of the central station is quite apparently not contributing to the merchandise sales of the electrical contractor but only diverting it to other classes of merchants. It may not be the proper time to turn electrical appliance sales over entirely to interests engaged as merchandisers only. There is still a big job to be done in California and elsewhere to promote the use of more appliances. The most effective means, and the most interested concern is the central station.

* H. C. Goldrick, Western Electric Company, chairman; G. W. Barker, Allied Industries, Inc., vice-chairman; W. C. McWhinney, Southern California Edison Company, secretary; R. E. Heerman, S. & H. Service Electric Company; Fred Lantz, Lantz Electric Company; J. H. Jamison, Westinghouse Electric & Manufacturing Company; E. A. Norton, Barker Brothers; H. C. Rice, Southern California Edison Company; D. D. MacFarlane, Newbery Electric Corporation; J. T. Deppe, Pacific States Electric Company; A. L. Spring, General Electric Company; L. E. Moselle, Los Angeles Bureau of Power and Light; H. B. Jenkins, Southwest Electric Company; J. C. Hobrecht, J. C. Hobrecht Company; Alfred May, San Diego Consolidated Gas & Electric Company.; E. S. Alexander, Alexander & Lavenson Electric Supply Company; H. A. Cram, Landers, Frary & Clark; M. S. Henoch, Westinghouse Electric & Manufacturing Company; B. M. Tassie, Manning, Bowman & Company; R. E. Tompkins, Pacific States Electric Company; A. H. Nicoll, Western Electric Company.

A Suggested Merchandising Plan for Central Stations

By A. L. SPRING and H. C. RICE

CENTRAL stations are interested in the sale of current consuming devices primarily from the point of increased use of current. They will obviously work out their own policies governing electrical merchandising, and it is not the purpose of this report to recommend an uniform policy, but to suggest a plan to those central stations interested in selling electrical household appliances.

A well organized sales department of a centarl station wields a tremendous influence toward popularizing the use of electrical household appliances and betters its public relations through the contact thus obtained with its consumers. As electric appliances can still be considered specialties requiring constant effort to maintain public interest, the central station merchandising department has a duty to perform to assist in introducing electrical appliances to the general public and in so doing will create a demand that will be reflected in increased business to all of the merchants handling electrical household devices.

Any central station merchandising department should carry itself. The merchandising department should be on a sound business basis and should carry a full line of appliances so that it will be in a position to render complete service to its consumers. The following plan is suggested in accordance with the plans of the appliance bureau, as outlined at the conclave in Los Angeles, Oct. 17, 1924.

At least four yearly sales should be held by the central station in which the entire industry can participate. It does not matter much which article is selected as an example, but it has been suggested that the percolator be the first article on which the sales drive should be made. These monthly sales should have as their special feature —

1. Low price
2. Easy terms
3. Some point of sale which can be highly advertised such as allowing $1 for the return of an old coffee pot.
4. The device selected should be such that any electric dealer or merchant can participate on the same plan if he so desires.

The appliance campaign should be used as a leader to get the public interested in other household labor saving devices.

From the central station standpoint such sales could be stimulated by allowing each employee a commission on sales made, in addition to his regular salary, increasing the commission for sales made out of office hours. In addition to the above special monthly sales, a plan whereby all employees of the company can be rewarded with a suitable commission in addition to their regular salary both on sales made in the office and on their own time, will materially increase the sale of appliances for any central station.

The electrical dealers can tie-in with the above plan with their own employees by using a similar schedule of commissions.

Every central station employs a great many people in various lines of work. Most of these have some sales ability. Many of them can be developed into remarkably good salesmen and saleswomen. By allowing each employee in the organization, to sell, and by paying a commission on each sale made, it can readily be seen that instead of having one or two salesmen working out of an office, there will be 40 or 50 or more, depending upon the number of employees. These employees will welcome an opportunity to make a little extra money through the sales of electrical appliances. The

following schedules of commissions are suggested, divided between office sales and sales made outside of the office.

On office sales a commission of 10 per cent to be paid; 5 per cent going directly to the person making the sale, 5 per cent to be pooled, the pool to be divided amongst those employees who do not come in contact with the public in the office, yet whose work would be increased by the added sales.

Ten per cent commission to be paid on outside sales, the entire amount going directly to the person making the sale.

Fifteen per cent commission to be paid on slow moving appliances. On office sales of this kind 7½ per cent will go to the person making the sale and 7½ per cent to be pooled. On outside sales the entire 15 per cent will be paid to the person making the sale.

Commissions should be paid promptly each week.

Office employees to qualify for participation in the pool must sell three appliances on each drive before they are eligible.

The central station plan of merchandising can be amplified considerably by offering groups of appliances at a special price and offering a premium for a limited time on such sales. Another important feature is to get the employees of the central station and electrical dealers to use electric appliances, and it is felt that special prices should be made to enable these employees to buy at the lowest price possible. A user of electrical appliances is always an enthusiastic booster. All advertising material sent out should be so worded as to direct the public either to the central station or to their nearest electrical dealer, when all concerned are agreed upon the particular sales campaign to be followed.

The above plans, if carefully worked out and followed up, should result in a great many sales being made by the central station employees in such a manner that the employee and company would be benefited by them. Commissions allowed are liberal in view of the fact that employees already are on a salary, and in the course of a month they should amount to a considerable sum.

A Dealer's Plan for Selling Small Appliances

By D. D. MacFARLANE and J. T. DEPPE

PRACTICAL merchandising is fundamentally based on factors and practices with which we are all familiar. We recognize the individual factors in the science of mechandising but we do not always realize that all of these factors and practices must be co-ordinated before the system of merchandising can function.

It is our intention in this article to disregard the contentions of those who claim that the sale af electrical appliances presents different problems from those presented by other lines—to disregard also the arguments of those who claim that to successfully sell electrical appliances other lines must be introduced. Our contention is that by recognizing the individual factors of merchandising and by applying them that the sale of electrical appliances can and will be increased whether the appliance line be sold by itself or incorporated with other lines.

Let us take some of the factors in merchandising, analyzing each in a brief way, viz: location, window display, attractive interior, merchandise well displayed, neat, courteous and intelligent service, merchandise that itself represents value. As this paper must of necessity be brief, we are not going to mention the subject of advertising, although we recognize it as an essential factor in the merchandising system. The amount and the kind of advertising that is done by individual stores depends so much upon the nature of the store itself that we believe it unwise to try to cover this important subject in a brief way.

The location we will have to take for granted as we are primarily addressing this paper to established dealers. We do not in any way mean to minimize the importance of the location but rather to accentuate the importance of merchandising routine in any given location.

In considering the important factor of window display, we would like to leave this thought: windows must be considered in the same light as a newspaper advertisement, and when a window is dressed it should mean something, just as definite as though an advertisement had been written.

The store interior we will also take for granted in the same way we accepted the location of the store. The arrangement and attractiveness of the interior we must give consideration to, although neatness, cleanliness, orderly arrangement and good illumination we do not always find, but surely there is no excuse for the lack of it. Even if a store is neat and clean, it may not always be attractive, but at least it will not have a negative effect upon the customer. The display of merchandise itself is a problem which needs constant attention regardless of the size or the nature of the stock.

The intelligence and courtesy of the sales people within the store must be carefully considered and personal appearance must be looked after. The sales people must of necessity know the merchandise which they are employed to sell.

The merchandise itself is, of course, the foundation of the whole merchandising structure. We must select attractive merchandise, appropriate merchandise. We must also recognize the appeal of price. Due recognition should be given to the fact that nationally known products both help to establish the store in a favorable position from the customer's viewpoint and to lessen the sales resistance encountered by the employees.

It is impossible to go into greater detail in this paper. We have told nothing new—a fact we recognize. Our only hope is that we may have brought home the fact to someone that in following just the fundamental principles in merchandising there are great possibilities for increased sales. To those who read this paper and are of the opinion that they have put into practice all of the factors of merchandising that we have discussed, thus briefly and inadequately, we can only ask that they walk out of their store—look at the window display as a disinterested person—then walk into their store—look casually around and make a purchase of some article that requires a display of salesmanship on the part of the clerks. We believe that looking at it from the viewpoint of a disinterested person, certain imperfections in a seemingly well thought out merchandising system will be observed. In other words, we all know the merchandising factors mentioned in this paper but in practice some of them are invariably overlooked.

Better Customer Relations Through Our Employees

Report of Customer Relations Bureau, Commercial Section*

THE first meeting of the customer relations bureau was held in Los Angeles Oct. 17, 1924. At this meeting the work of the customer relations bureau of the previous year was reviewed by the chairman and a resume of the discussions and annual report was presented to the new committee.

Each member of the bureau was called upon to give his general idea of the importance of customer relations activity and the bearing which it might have upon the general problem of securing favorable public relations between the central stations and the public. From the thoughts that were brought out in these statements it was plain that the subject of proper customer relations was a very important one in the minds of the bureau members.

As a result of the ensuing discussion it was decided by the bureau that the subject was too large and too broad in its scope to be attacked in its entirety by any one year's committee. To procure successful results would entail more research and more labor than the

time available to any one year's bureau would permit. It was the consensus of opinion that the bureau for 1924-25 should concentrate its efforts on some one phase of the subject for a thorough study and a report embodying concrete and definite recommendations.

With a view to carrying out this policy the bureau decided that probably the most important subdivision of the problem of customer relations was that of employees' relations with the public, and that this resolved itself primarily into the question of the conduct of the employees in their daily contact with our customers.

It was then decided by the bureau members that the principal activity for the year should be the compling of a set of instructions which would definitely outline to our employees their proper conduct when transacting business with our customers. For purposes of preliminary study, the subject was divided into several subdivisions, each member of the bureau assuming the task of studying the conditions surrounding his particular subdivisions and of preparing suggestions and recommendations to the chairman for further discussion by the entire bureau at a later date.

The second meeting of the customer relations bureau was held at San Rafael, Nov. 19, 1924, upon the occasion of the meeting of the National Commercial Section. The session was a closed meeting, entirely informal, and was for the purpose of going over the work which had been done by the various members of the bureau up to that time. The suggestions which had been turned in were analyzed and final decisions were made for the benefit of the chairman, who was to compile the final draft of the instructions to employees.

This set of instructions, or employees' manual, has been made the major part of the report of this year's bureau. It is the result of a great deal of thought and study by the bureau members individually and collectively. The bureau believes that the proper conduct of our employees when they are transacting business with our consumers is the very foundation upon which to build a structure of satisfactory public relations, and it believes that in the set of instructions which they have compiled they have furnished a method by which any company executive can instill into his employees a knowledge of the proper manner in which those employees shall act in their daily routine work.

These instructions will not be self-executing, of course, as is nothing of this nature. They will require conscientious interpretation and application by those in the company organizations who are directly responsible for the actions of their employees. But the committee believes that it has supplied in written form that which we have hitherto lacked, i.e., a short, terse guide to the proper conduct of employees. It is the earnest hope of the bureau members that it will meet with the approval of the Commercial Section.

As was stated before, the question of satisfactory customer relations is a large and complex one and contains many factors. The bureau wishes to bring to the attention of the Commercial Section some of the more important ones not only to bring about a realization of the various problems involved, but also as a suggested basis for the work of the bureau during the coming year. It must be remembered that there is no particularly new and astounding thought to be brought out; that there is no strategic move to make which will at once cure all of our troubles, but that on the other hand, improvement of our customer relations will only come through continual effort, never-failing patience and the performance of one small act of courtesy or service at a time. Our final favorable position in our relations with our customers will be the result, not of one big activity, but of an infinite number of small acts, performed one after the other.

One of the most important subjects which attracted the attention of the bureau members was that of the possibility of having a higher type, or perhaps we had better say, a better adapted type of employee in those positions where we come in contact with our customers. There is not a company which to a greater or less degree does not have in its organization men who are not suitable for their positions, due perhaps to some lack of education, training, or personality. We believe that this calls for the best attention on the part of company executives, and that any thought and effort which can be spent along this line in an endeavor to remedy such conditions will be amply repaid.

Having a close connection with the above thought are two additional ones; that of closely watching the scale of pay of employees in work of the character under discussion, and that of providing a more definite advancement or promotion plan. With reference to the first thought, often it will be found that to obtain the employee suitable for some particular class of work will call for an increase in the pay for this work. There should be no hesitancy in carrying out such a policy, for if there is any place in our organizations where men and women can be valuable to us and worthy of their hire, it is in those places where they meet our customers and are in position to make friends or enemies for our companies. The result of their actions are usually not known to us until afterwards and the damage which may have been caused usually far exceeds in cost the slight additional pay which a more suitable employee should command.

A definite promotion plan will also be of distinct assistance in procuring the proper type of employee. It is human nature for any of us to work harder and more conscientiously when we can see the next step in our upward clim. Nothing so stifles an employee's initiative and ambition as to be in a place where he cannot see something definite ahead. It is the belief of the bureau members that this phase of the status of the employees is worthy of serious study.

In connection with the thoughts which have just been noted, the bureau wishes to call attention to the policy of one of the large oil companies of California, which has made an enviable record in winning a favorable opinion from the public, through the inauguration of a public relations policy which has functioned chiefly through the actions of its employees who are in contact with the public. Quite a thorough study was made of some of its practices, made available through the courtesy of the oil company officials.

The company has a definite promotion plan, which provides a man, as soon as he goes to work in a service station, with a definite future, so that he knows at all times what he has to work for and what the rewards of his efforts will be. In recruiting its service station operators (which, by the way, officials state to be the source of the larger part of the male employees), an endeavor is made to obtain college graduates. The company pays a scale of wages which runs a considerable percentage above the prevailing scale for a similar class of work. A man must not only be physically suited to the work, and, in fact, pass a physical examination, but he also must be fitted temperamentally for the location in which he may be placed. In a city like San Francisco, for example, the officials state that they are exceedingly careful not to place men in the residential district of Ingleside Terrace when they should be in the manufacturing district south of Market Street. They claim to have noticed very direct results in the financial returns in a service station when the wrong type of man has been stationed there. To illustrate how carefully they have gone into this subject, we are allowed to state that they now have gone so far as to place a height and strength limit below which an applicant must not fall. Their reason for this is that when a man is promoted from a service station to a tank wagon they have found that the work was so arduous that a small man usually was not capable of doing the day's work without being physically so exhausted as to be unable to present the courteous, cheerful manner which they desired to have him exhibit at all times. Certainly, if this oil company, with its exceptional record of results, has found it desirable to go into this question of the fitness of its employees for their particular position to the extent which it has done, it must be worthy of serious consideration.

Another phase of the customer relations question which received attention of the bureau was that of the proper education of employees. This is a large subject in itself and includes not only their education in the requirements of their particular job but also education in respect to general company policies, company activities, physical facts concerning the company and information concerning public utilities. This educational work is being done to a greater or less extent in practically every organization, but with very little uniformity of plan. Some companies were found which carry on more or less extensive work along one or more of these lines, but practically ignore the rest. In some of the companies the work follows a general scheme which is in effect throughout the organization, while in others this

work has been dependent upon the initiative and ideas of various department heads, resulting in the education of only a few of the employees.

The bureau believes this work to be of sufficient importance to call for a more detailed investigation of company methods, results attained and the dissemination of this information among member companies. The bureau members also wish to go on record as expressing the belief that the most of this work is not the proper function of employees' organizations. This work should be a definite part of fitting the employees for their positions, and it does not seem that it falls within the scope of activity of an organization where attendance and study is a voluntary matter.

At this point we wish to call attention to the "Employees' Manual" which is being distributed by the National Electric Light Association to the member companies. It is an excellent compilation of information valuable to public utility employees and should produce beneficial results. The manual which this bureau submits, will in no way conflict with the one above mentioned, but rather will supplement it, as the entire manual of the bureau is covered in two pages of the N.E.L.A. publication.

A subject also discussed at some length was that of providing uniform dress for its employees whose work would lend itself to such a practice. This applies more particularly to meter readers, trouble shooters, meter men, etc. It is believed that two distinct objectives would be gained by following such a course of action, both of which would have a favorable bearing upon customer relations. The first would be a neater personal appearance of the employees, and there would also be a psychological effect which the uniform would have upon an employee which is of some consequence. We believe that the general result would be better appearance and a more alert and business-like manner on the part of the employees. Second, there is no question but what the public would be much more favorably impressed with the employees, and the uniform would also instill a certain amount of confidence in the customer, with a beneficial result. The bureau feels that an investigation to ascertain the number of companies who are now following this policy and their opinion of the results attained, would be of value to the member companies.

As stated before, the bureau has made no pretense of covering the entire subject of satisfactory customer relations in this year's work. It has endeavored to call attention to some of the more important phases so that they might receive your thought and consideration as well as act as suggestions for the next year's committee and it has endeavored to provide a definite answer to one of the questions presented by this subject. The bureau does not feel that it is within its province to lay down the work for the next year's members, further than the suggestions which have been made, believing that the incoming committee can best determine for itself the most important line of investigation which it should undertake.

The bureau presents this report, together with the "instructions to employees," which follow, with the hope that it will arouse in the members of the Pacific Coast Electrical Association, to some degree, a realization of the importance of satisfactory customer relations, and with the hope that it has presented a certain amount of assistance in the solution of one of the important questions involved.

To Member Company Executives

Much has been written and more has been spoken on the very important subject of "Public Relations." It is regrettable that so many of the written words lie hidden and unused in our desks; that so many of the excellent ideas to which we have listened with interest at conventions, with a determination to put them to practical use in our own organizations, have faded into the limbo of forgotten things before we are fairly at our desks again.

But progress is being made. And most significant in this progress is the growing realization that, of the many angles to the problem of satisfactory public relations, the one which embraces our direct personal contact with the customer is without doubt the most important; and further, that this portion of the problem will never be solved by broadsides of publicity directed to the public en masse nor by exhortations to our employees on the subject of good service. We must go farther than these methods allow us, and it is necessary to analyze more minutely our objective and the paths thereto.

In doing so, we find that our relations with our customers are determined primarily by the actions of the rank and file of our employees and very little by the personal behaviour of the management. While our executives are coming in contact with one customer, the employees are meeting hundreds. It has been and will continue to be a shock to many of our executives to learn at some time or other, in spite of their high ideals of courteous treatment and adequate service, in spite of their orders and instructions given to employees in an effort to transform these ideals into realities, that the public still does not receive the standard of service or courtesy which the management desired should be given.

The reason for this state of affairs is two-fold. First, the number and character of our points of contact with our customers have not been properly analyzed and their significant factors sufficiently appreciated; and second, it does not suffice to tell an employee to "do" or "be" something; we must also tell him "how." And the "how" in this case is the significant point in the solution of our problem.

In making our inquiry into our points of contact we find that they are several in number and that they include almost as many different mental types. It is perfectly obvious then that different methods must be employed to convey the same idea to all of them if we are to obtain a uniform impression in their minds. To order "courtesy" will produce entirely different actions in the college graduate, and the workman who earns his pay by the sweat of his brow. To instruct them to be neat means one thing to the counter clerk and something entirely different to the meter setter. And yet it is easily possible for both of these employees to fulfill our ideals.

A study will show that for each group of employees who make contact with our customers there must be a distinct and different method of imparting instructions, in order to insure a uniform understanding of how we expect them to assist us in attaining our ideals of courtesy and adequate service. As indicated above, neatness must be explained and defined in one way to a counter clerk and in an entirely different manner to a meter setter. To do this effectively it will be necessary to determine not only the various positions in our organization where our employees meet our customers, but—and this is most important—we must analyze the mental characteristics of the class of employees who will be likely to be found in these positions.

A search through available written material revealed nothing specific to meet this particular requirement. There are plenty of admonitions to instruct our employees and emphatic reminders of the necessity of good service and courtesy if we are to enroll our customers on our list of friends. But there is apparently a dearth of material to assist the man who actually desires to give detailed assistance to the employees in his organization. This is the condition which has served to justify an attempt in this direction. The "instructions" which constitute a part of this report represent an effort on the part of the customer relations bureau of the Pacific Coast Electrical Association to supply some concrete, definite assistance to the man who wishes to transmit to his employees some specific instructions as to their treatment of the public. It is not expected that it will prove a cure-all, nor are the "instructions" self-sufficient. They merely provide the groundwork for further effort on the part of the company official who desires to improve the conduct of his employees but lacks a definite and specific foundation.

While these "instructions" are compiled for direct distribution to the employees, such an act alone will be of little value. The majority of our employees will not accomplish much in this direction through their own initiative. To them it is difficult to convey the importance of this subject. Only by the most painstaking efforts and continual watchfulness can we imbue their minds with our ideals of service and the methods by which we strive to attain them. Therefore, it seems necessary that the group executive, whether he be foreman, chief clerk or local manager, be held directly responsible for the manner in which the employees absorb the spirit of these instructions. His degree of sincerity will measure the results which will be obtained from the employees. He must act as interpreter and critic,

and it is to him particularly that we hope we may have been of assistance. Successful results will further depend upon the support given the group executives by their superiors, and little good will result unless it can be known throughout the organization that the company executives demand that the customer receive the utmost of courtesy and service.

The "instructions" are self-contained and are intended for individual distribution to the employees. All the material is suitable for study by all departments.

The language of the suggestions has purposely been put in brief and concise form. It was felt that this form would better convey a specific idea than would too much elaboration. Furthermore, the expansion of the idea presented is really the function of the group executive and it is in this that the opportunity is presented to convert the employee to our way of thinking.

Great care has been taken to avoid any statement which would conflict with any company's policy or routine procedure. The sole purpose has been to convey to the employee the correct idea of what his conduct should be when he is in contact with the public. It is hoped that his effort will assist in some degree the solution of that very important phase of "Public Relations"—"Employees' relations with our customers."

* H. K. Griffin, Western States Gas & Electric Company, chairman; F. V. Boller, San Joaquin Light & Power Corporation, vice-chairman; Robert Cardiff, Coast Counties Gas & Electric Company, secretary; D. C. Ray, Pacific Gas and Electric Company; P. S. George, Coast Valleys Gas & Electric Company; G. M. Rankin, California Electrical Bureau; Alfred May, San Diego Consolidated Gas & Electric Company; L. D. Sherman, Great Western Power Company; A. W. Childs, Southern California Edison Company.

The Proper Treatment of Our Customers

Prepared by Customer Relations Bureau, Commercial Section*

Your Responsibility

DID you ever realize that what a consumer thinks of you is often what he thinks of this company? Did it ever occur to you that thousands of this company's consumers have never met more than one or two of our employees? Is not their opinion of our company almost certain to be based on the treatment you have given them?

It follows then that **you are the company** to the most of the people who patronize us. If you have been courteous, performed your work intelligently, answered questions patiently and have given the treatment you would like to get yourself, then that consumer will form an opinion of our organization that will be a credit to you and to us. If, on the other hand, you have not conducted yourself in quite the proper manner, the impression left with that person is one of antagonism, or at least dislike, which may take years to overcome. Indeed it may never be entirely corrected.

This company is selling a service; not something to be bought by the pound. It is a service that is necessary to the life, health and business of our community; almost as essential as the air we breathe. If we fail in our daily duties and our service ceases, our fellow citizens have nowhere else to turn; they are dependent upon us for something that is vital to their very existence. We all of us have, then, in addition to our daily work, a responsibility to our community; the responsibility of furnishing a service which is a necessity of life. Our consumers demand, and rghtly so, that this service be rendered courteously, and in a way that will cause the least inconvenience to them. If they receive this kind of service they will be our friends, and our list of friends is the biggest asset of this company.

We are striving constantly to improve the quality of our service but we must depend upon you to give it. The largest part of the responsibility of this service rests with **you.** As it depends so greatly on you to see that our customers receive what we are trying to give them, it is natural that we should watch your treatment of them. We have found that people are quick to appreciate earnest efforts in their behalf, and we wish to recognize those of you who put forth these efforts. Need it be said that advancement and promotion will come more quickly to those of you who have made a record of honest endeavor to give service to our customers?

We recognize that mistakes are often committed unknowingly. We are, therefore, giving you a few instructions so that you may know exactly how we want you to treat our customers. It is the little things in life that count, and it is the little acts of courtesy and the little efforts toward service which will be remembered by our customers, for they mean so much to them. These instructions refer entirely to **how** your work should be carried on, and not to the details of the work itself. Routine may change from day to day, but its object will always be more and better service, given with a maximum of courtesy. A thorough understanding of the spirit of these instructions will be invaluable to you in your work. It can always be followed no matter where you are in our organization.

To ignore the instructions that we are giving may be the cause of making enemies for us. To follow them will assist us in giving the service we desire and will build up a record for yourself that will be of great assistance to you in the advancement for which we are sure you are striving. We are offering these instructions to help you make yourself better in your work. If we succeed in that, our company will benefit, and we do not need to emphasize that your prosperity depends upon the success of the company for which you work.

General Instructions

On the following pages you will find instructions to different classes of employees in our company. These have been prepared to guide you in your daily contact with the public. We desire that all employees read all of the instructions contained herein, paying special attention to the ones given under your particular classification.

It should be noted, however, that there are employees in our company whose work does not come under any of these classifications, but who, nevertheless, are in touch daily with some of our customers, perhaps at home or at social gatherings. In the instructions which follow, such employees will find the suggestions which will fit their case and which will be easily recognized by them.

If any doubt arises in your mind as to the particular instructions which apply to your class of work, the head of your department will be glad to discuss them with you.

Courtesy to Your Fellow Employees

Be courteous to your fellow employees. Your first thought will be the question: "What has this to do with the public?" The connection is indirect but very apparent. When you have been treated discourteously by a fellow employee you feel it and are very apt to show it in your manner. If the next person with whom you deal is a consumer, you will probably be a little less considerate toward him even though you may be unconscious of any change in your manner. Courtesy between employees will secure more polite treatment by all of us to our customers.

Apart from this personal side, mutual courtesy will create a feeling of fellowship and friendliness throughout our organization which will make our work more pleasant for all of us. The effect of this spirit cannot help but secure more considerate attention to our consumers.

Cooperation Between Departments

Quite often in the course of your duties, it may be necessary for you to work with other departments of our organization. When this occurs, approach that department in the spirit of cooperation rather than that of shifting responsibility.

By working in harmony, friction is eliminated and the work is accomplished in less time, with much better satisfaction to the consumer and at smaller cost to the company.

Should an error, made by another department or by a fellow employee be brought to your notice, do not feel, since it is not your mistake, that you have no responsibility in the matter. Correct it if possible, and if you can not, call it to the attention of some one who can.

An error, however small, if not discovered and corrected at once may cause needless inconvenience to the consumer and expense and trouble to the company.

Outside Criticism

Never criticize another department or employee of our company when talking to a consumer. If you can-

* A few instructions to guide central station employees in their daily relations with the public.

not make a clear explanation of the subject under discussion, simply state that you will have it investigated. Criticism of your organization or any part of it to outsiders shows your lack of confidence in it. Consumers will not have confidence in **your** statements or judgment if you show that you have none in your fellow employees. When you make such statements you destroy confidence in yourself as well as in your company. You have hurt yourself and have not helped the consumer. Nothing will so quickly destroy our confidence in you as to learn that you criticize our company or your fellow employees when in conversation with our consumers.

Report Complaints

If any complaint, misunderstanding, or case of poor service on the part of our company comes to your attention outside of your regular work, report it promptly to the department concerned. This will allow us to give much quicker attention to the trouble than might be the case if you did not report it, and it also will be valuable in that the customer will appreciate your interest in him, and will more readily believe that we wish to give him the best possible service.

Rates, Rules and Regulations

Do not attempt to explain rates, rules and regulations to consumers unless you are sure you thoroughly understand them. If you are at all in doubt about the question, refer it to the proper department. There are many mistaken ideas among our consumers about the manner in which our company must operate. You will be doing any consumer a favor and making friends for the company when you assist in clearing up any misunderstanding, either by giving the proper explanation yourself or by referring the matter to the one who can do so.

Service Before Routine

Do not allow yourself to become a slave to routine. While it is necessary that this company work by certain standard rules, yet our first desire always is to render service to the consumer in the best possible manner. To do this it is often necessary for you to depart from our regular procedure, and at times to request the assistance of other employees and departments in order to accomplish the desired results. If you have not the authority to do what seems necessary, consult the head of your department. Your efforts in this respect to assist us in serving the consumer will be very pleasing to us and will work to your advantage.

Proper Use of Telephone

The proper use of the telephone by all employees is one of the most important phases of our company's business. The customer can not see you and must judge you solely by what he hears and how he hears it. To create a pleasing impression by telephone is not always easy, and the endeavor to do so calls for your best efforts.

Answer your telephone promptly.

Never say "Hello." Answer by giving your name and department. If the call is received directly from the outside without coming through a company switchboard, give the name of the company first, followed by your own name.

Give close attention. The party calling has the right to expect that you are listening to him. Don't force him to repeat due to your inattention.

Keep your mouth close to the telephone and talk in an ordinary tone of voice. Shouting will blur your speech and talking too low will make your words difficult to understand.

Use a pleasant tone. Your voice is your only means of impressing the consumer that you are at his service. Make it courteous.

Don't argue. You are justified in making statements of fact as near as you know them, but don't argue about them. You may be wrong and you weaken yourself and your company by being drawn into an argument.

Let the consumer close the conversation. Don't run the risk of hanging up before he is through.

Say "Thank you" when possible in closing a telephone conversation. This is proper in many more instances than might appear at first thought. For example, it is right that we should thank any customer for calling in regard to a complaint, for we appreciate information as to laxity in our service and we welcome every opportunity to clear up a misunderstanding of any kind with a consumer.

If a person called is not available, be sure that the name and telephone number of the party calling are transmitted to him as soon as possible. Assure the consumer that you will give his call to the person to whom he wishes to speak.

If, by chance, you have been called by mistake and are not the one with whom the consumer wishes to talk, be especially courteous and use your best efforts to get the right one in our organization for him. It was probably not the error of the party calling and your effort to accommodate will be appreciated.

When desired information cannot be given without undue delay, request the name and telephone number of the consumer and say you will call as soon as possible. **Don't fail to keep your promise.**

Above all, be courteous in tone and words; **the consumer can only "see" your voice.**

Salesmen

A neat personal appearance is more essential to the salesman than to almost any other class of employee. First impressions are the most lasting and an untidy appearance will create an unfavorable opinion of you and your company.

Make a practice of shaving daily. Keep your shoes shined and your clothes cleaned and pressed. Clean linen is inexpensive and essential. Be careful of the appearance of your finger nails. Watch these details and avoid any chance of personal criticism.

Avoid the use of tobacco while conversing with others. It may be offensive to them.

If you are a power salesman you must be thoroughly familiar with your company's rates and regulations. If you are selling appliances you must know your merchandise. Such knowledge is absolutely essential if you are to create a feeling of confidence in your prospective customer.

Keep in mind that your prospective customer knows his own business better than you do. He may even know more about the application of your commodity to this business than you do. Go carefully until you know your ground. Show every consideration to his opinions.

Do not make promises unless you know they can be fulfilled.

By many of the people with whom you come in contact you are looked upon as being an authority on company matters. It is therefore essential that you keep fully informed in regard to the operations and general policies of the company. You must use great care in making statements and promises. If you are asked a question and are in doubt as to a correct answer, do not guess. Tell your questioner you will obtain the requested information for him. Take no chances on an incorrect or ambiguous reply. It may cause serious trouble for your company and the consumer.

You will often be required to listen to complaints concerning some part of our company business. Give such matters your full attention and refer them to the proper department. We consider such work just as essential to your success as obtaining the new business.

You have an exceptional opportunity in your work to build up good will for your company. Your word is accepted as authority on company business. Use all care that you do not put yourself and the company in an embarrassing position by giving information carelessly, or inaccurately. This will destroy confidence in you and in us.

To a salesman it should not be necessary to speak of courtesy. To be successful you must have it in a certain measure. But we also ask you to give "consideration" to the people with whom you come in contact. It is the highest type of courtesy. Be considerate of their opinions, their circumstances in life, their surroundings. You must avoid the "know it all" attitude. Regardless of what you are doing, it will make friends for you and for us.

Applications and Contracts

In the majority of cases you are the first of our employees with whom our consumers come in contact. The impression made by you at this initial meeting will, to a large extent, determine their idea of this company. First impressions are always most lasting and it is

with this in mind that we urge upon you the importance of using every effort to correctly carry out your duties with proper courtesy and consideration to our consumers.

Special attention should be given to your personal appearance. Clean linen and well kept hands are essential.

A thorough knowledge of our rates and regulations is absolutely necessary. Take time to make a full explanation to the consumer of the particular condition applying to his installation. Be most particular in obtaining correct names and addresses from the consumers. Misspelled names may mean a delayed bill, and wrong addresses are almost certain to cause a delay in service to the consumer as well as any amount of extra labor and trouble in other departments of the company. You cannot use too much care in this part of your work.

Make your explanations in simple terms. Remember that your everyday "working" language is as so much Greek to the majority of consumers. Talk to them in terms that will be plain to them and don't resort to the routine language of the office.

Be sure that you understand exactly the class of service desired by the consumer and that the correct rates are applied. It is often necessary to question the consumer to a certain extent before you will be certain as to what class of service is desired. Guard against appearing impertinent or inquisitive.

Be careful about giving figures as to monthly cost of service. Consumers often request information as to what their bills will be, and they are quick to take any statement of ours as a promise on our part. Avoid this. If necessary, do not hesitate to refer them to the department which can go into the matter more fully.

Do not make ambiguous statements. They oftentimes cause us a great deal of trouble. Leave no room for doubt in the consumer's mind in regard to any part of your conversation.

Avoid the use of the phrase "You will have to." There are many other ways of telling the consumer that it is necessary for him to do certain things to conform to our regulations. None of us like to be told that we "have to" do anything. In the case of a public utility particularly, people resent this phrase.

Be interested in the consumers. Make them feel that you have a personal interest in their affairs as far as our company is concerned. They are almost wholly ignorant of our business and a personal interest displayed by you will cause them to feel that we are anxious to assist them. Remember that each consumer at the counter is a human being like yourself.

And last, and most important of your duties, is courtesy, always and never failing. It is most productive of success in your work and at times it will be most difficult to achieve. You will have those to contend with that will try your patience until courtesy seems almost impossible. But courtesy on your part will keep you in command of the situation and can never bring criticism upon you. It is your best weapon against the "hard to handle" customer, and your characteristic which will be longest remembered by all of them.

Requests for Information

These may come to you no matter what position you may hold in our organization and it is needless to point out the importance of the replies you give. It is essential that they be correct, and if in any doubt, be sure you obtain the proper information for the consumer.

If you are a telephone operator or information clerk it is your duty to be thoroughly familiar with the work of the various departments and the men in those departments who meet the consumers. Use great care to see that the consumers are directed to the proper person in our organization. It is very annoying for them to repeat their story several times to different people before they reach the right one.

It will often be necessary to question the consumers considerably in order to know where to direct them. This must be done tactfully and courteously. Remember that they probably know nothing of our organization and have little idea of how our work is conducted. Do not become impatient if they do not seem to know just what they want. Our business is a mystery to the most of them.

Cashiers

The payment of any bill is not particularly agreeable to anyone; make the payment of bills for our service as pleasant as possible. Be neat in your personal appearance. Greet each consumer with a smile, a pleasant greeting, and a "Thank you" when he leaves. Do not turn away from a consumer until he starts to leave.

Do not argue regarding a bill. If you cannot explain the account to the consumer's satisfaction, refer him courteously to the person whose duty it is to investigate such matters.

Make change promptly and carefully.

When currency, from which change is required, is given in payment, leave the currency in sight of the consumer until the change is counted and accepted. You will thus avoid any argument as to the amount of currency given you.

Do not carry on unnecessary conversation while other consumers are waiting.

Do not leave your desk during rest periods unless someone is at hand to relieve you.

Complaints

In interviewing consumers who have complaints, you have one of the most difficult and important duties of any in our organization. Bear in mind that in the majority of cases the consumer is sincere and is convinced that his grievance is legitimate.

Consider that this consumer is entitled to your full attention while you are interviewing him. Endeavor to make him feel that you are taking a personal interest in his case and will see that he gets everything to which he is entitled. To do this successfully you must be sincere in your manner and thorough in looking into the grievance. Don't neglect anything which may have a bearing on the case. It may cause a worse complaint later.

Give those complaints which come in over the telephone the same thought and attention as those reported in person by the consumer.

Be courteous—never risk embarrassing yourself or the company by arguing or insisting that the consumer is at fault. Many times he is not.

Investigate each complaint thoroughly and follow it up until it has been attended to, with the idea always in mind that any trouble that may exist should be corrected as soon as possible.

Do not make promises unless you know without doubt that they can be fulfilled.

Remember that the consumer is not as familiar with our service as you are, and do not confuse him with technical terms. Use simple language in your own explanations. He will appreciate your courtesy in not confusing him with unfamiliar words.

Accounting Department Employees

Although your work does not often bring you in personal contact with the public, yet the quality of your work has an important bearing upon our relations with our customers.

An error in computation leads to a complaint which always takes time and effort of other employees to correct.

But the worst result of an error is the impression left with the consumer that he "caught" us in a mistake.

Make plain figures. Illegible figures lead to mistakes by other employees. When appearing on a bill, they exasperate a customer.

Collectors

Collectors have one of the most difficult jobs in our organization. No one likes to be dunned even though they know the bill is just. To keep the right balance between collections and satisfied consumers is no easy task.

Do not allow yourself to depend wholly upon the "money or meter" policy. While in some cases it is necessary for us to remove a meter for non-payment of account, yet when that meter is out we are earning no money at that address. Removal of the meter should be the last resort.

You will be judged by the skill you show in obtaining payments and terms for settlement without resorting to meter removal. Many delinquent accounts will show possibilities of settlement within our rules, if they are examined with tact, courtesy and a little human kindness. In cases of dispute, don't argue. Verify your

facts. The apparent delinquency may have been the result of our mistake.

Be neat in your personal appearance.

Above all, be courteous and polite in all cases. Allow no provocation on the part of the consumer to cause you to forget your dignity and that of the company you represent.

Setting and Removing Meters

Be clean. Self respect is largely a matter of personal appearance, and you cannot expect the people with whom you come in contact to have respect for you unless you show respect for yourself. Just because you wear working clothes is no reason why you should not shave regularly and keep your hair combed.

Be courteous. Answer questions courteously, even foolish ones. Remember that your work, which appears simple to you is more or less a mystery to the average man or woman. If the consumer desires to be shown how the meter is read, a short, simple explanation does not take long, and will usually convince the consumer that there is no magic, or what is more important, no guess work about it.

In a great many cases you are the first representative of the company with whom the customer comes in contact, and it is essential that you make a good impression. On entering the porch or house of a consumer, wipe your feet, remove your hat, and while doing your work try to make as little dirt, noise or fuss as possible.

Insofar as the company rules permit, you should check over the consumer's appliances before turning on the service, to make sure that our meter and service are of sufficient size. If there appears to be trouble when the service is turned on, do not condemn the man who made the installation, but look around for the defective device which often is the cause of the trouble.

If you cannot set the meter due to some defect in the job or to some infraction of a rule, such as wrong type of meter box, doors too small, etc., be sure the consumer understands the cause of the delay. Don't say "It's the company's rule" and let it go at that, but try to explain the matter from the standpoint of safety or convenience to the consumer.

Leave the consumer's premises in as neat a condition as you found them. Don't walk over lawns or flower beds, and when you enter or leave the yard close the gate after you. These may seem to you to be small details but they mean a great deal to the average housekeeper.

Familiarize yourself with the company rules which apply to your work and if there is any doubt in your mind as to the proper interpretation of any point, consult the head of your department as to the correct meaning of the point in doubt.

If in some respect the information on your work orders does not agree with what the consumer has in mind, do not try to place the blame on anyone. Explain the discrepancy the best you can without criticism, and clear up the matter when you get back to headquarters. If mistakes in other departments cause you trouble, report them to your superior. Do not tell your troubles to the consumer. Read the paragraph on "Outside Criticism" under "General Instructions."

Meter Readers

Be clean. Shave regularly, and if you wear a white collar, be sure that it is clean; a clean soft shirt collar looks a great deal better than a dirty white one.

Be courteous. Remember that the meter reader is almost the only representative of the company with whom the consumer comes in contact after the original installation is made. Every word you say, every move you make, and particularly your appearance will be a contributing factor in forming the consumer's opinion of, and attitude toward the company.

Don't jump fences or walk on lawns or flower beds. If the meter is in a locked porch or other enclosure, and there is nobody at home, do not force an entrance. Treat the consumer's premises as you would want your own place to be treated.

Be accurate. Remember that bills are made out from your readings and a mistake on your part usually causes a great deal of trouble.

Trouble Shooting

You have an exceptional opportunity in this work to make friends for our company and leave behind you a record of courtesy and helpfulness which will be of great assistance to us and to yourself. Every call you make is the result of some trouble or inconvenience to the consumer. He is looking to you for help and when you give him assistance in a polite and courteous manner you leave behind a friend to you and to our company.

On arriving at a house in the daytime go to the rear door; if at night call at the front door to avoid frightening anyone who might be timid.

State your errand briefly and if your company credentials are requested, produce them promptly and pleasantly.

Be sure that you remove your hat upon entering the house. See that your shoes are clean.

If necessary to stand on a chair, ask for a kitchen chair and see that the seat is properly protected by paper or otherwise.

Be sure that any dirt you may have made is cleaned up before you leave.

If the cause of the trouble is not immediately apparent, take sufficient time to locate it and be sure the consumer is satisfied before you leave.

If you are unable to make a permanent repair at the time, see that the proper notation is made on the trouble tag in order that it may be followed up by the right department.

If the trouble requires work for which the company makes a charge or which should be handled by an outside contractor, explain this to the consumer so that it is clearly understood.

If you see any fault or defect in our own system be sure that it is noted and turned in on your report so that it may be corrected by the proper department.

Do not make promises unless you know that they can be fulfilled.

Answer questions asked by the consumer to the best of your ability. Many of them may seem foolish to you. But remember that your business is a mystery to most people and a courteous reply will be appreciated by them.

If they desire information which should be given by other deparments, put the proper notation on your report so that it may be followed up.

Insofar as your work will permit, keep up your personal appearance. Neatness and cleanliness will go far toward making a good impression on the consumer for the company and yourself.

Construction Crews

Normally your work does not bring you in personal contact with many of our consumers. But do not think they do not see you. The public loves to watch a crew of workmen and they are quick to judge a company by the way its men carry out their duties.

You do not have time to carry on conversations with the public but you will be asked questions now and then. We must leave it to you to know how much time to give to such questions, but we expect you always to be courteous. Rudeness is never called for and is inexcusable.

In working on or near private property, be considerate of the owner. Use the same care with his lawn, fences, flower beds, etc., as you would like to have shown to your own property. There is no excuse for unnecessary damage and we will not tolerate it.

Truck and Automobile Driving

Your car or truck is plainly marked with our company name. You are our representative and we are judged by your actions.

Know the traffic rules thoroughly. Drive carefully. There will be no excuse for breaking the law's requirements.

In heavy traffic don't crowd other cars. Don't be a "road hog." Extend the courtesy of the road at all times.

The public service license on your car does not give you the special privileges of fire apparatus and ambulance. So watch your speed.

Remember that the conduct of automobile drivers is always subject to special attention on the part of the public. Any discourtesy of yours is a reflection on your company.

In Conclusion

When you have read the foregoing instructions carefully you will, no doubt, have seen that they could have been condensed into one short sentence, one which

we have all known for many years, "The Golden Rule." But we have interpreted this rule for you at some length so that you might know exactly what would be expected of you. In this way there will be no misunderstanding by any of us.

As we stated in the beginning, we are selling a service to the public and we desire and insist that this service be rendered with the maximum of speed and courtesy. In no other way can we justify our company's existence. That is the purpose for which we are in business. It is the only way in which we can succeed.

You are looking for advancement and success. In a large measure this depends upon the success of this company, which in turn to a great extent rests with you and depends upon the manner in which you carry on your work.

We have endeavored to blaze the trail to guide you on your way. We know you will not fail in an honest endeavor to follow it.

An Analysis of Domestic Metered Water Heating in California

Report of Metered Water Heating Committee, Electric Cooking and Heating Bureau, Commercial Section*

THIS report is purposely limited to statistical data showing the state of development of the electric water-heating load in California; load characteristics so far as obtainable in the short time available; and the present tendency.

Comprehensive questionnaires were sent to all the member power companies in California asking for information on the following subjects: characteristics of water-heating load; effect of water-heating load on range load; average consumption of water heaters; load characteristics of water heaters of various capacities; proper size tanks; effect of installation on water heating system; proper inter-connection between range and water heaters; diversity of water-heating load; effect of water-heating load on system peak.

All of the companies sent in as much information as was available from their records. Nine power companies reported 7,183 water heaters of the capacities and types shown in the accompanying tables. (The numbers 1-9 used to refer to central stations are for the same companies throughout the report.)

The following table shows the monthly kw-hr. consumption reported:

	Central Station								Ave. monthly consumption
	1	2	3	5	6	7	8	9	
Monthly kw-hr. consumption where contiuous automatic hot water service is supplied	324		544	100	987	527		489	574
Monthly kw-hr. consumption where water is heated intermittently only		278	207		360	160	159	150	210

To questions relative to load characteristics the following replies were received:

Question: What is your estimated diversity factor?
Answers: Company 1—We do not know.
Company 2—3 to 1.
Company 3—No particular study.
Company 5—No figures available.
Company 7—No data.

Question: How do the larger water heaters affect the system?
Answers: Company 3—Larger size heaters which we recommend materially increase the demand occasioned by the range load.
Company 5—Not noticeably.
Company 9—Do not consider either appreciably on peak.

Question: How does the water heater affect the range load?
Answers: Company 5—Considering the increased revenue, the combined load is more profitable than either load separately.
Company 7—Not entirely diversified. Estimated increases range peak 30 per cent of water heat load.
Company 9—None when on double throw switch.

Question: What is your rate for water heating?
Answers: Company 1—First 150 kw-hr., 3.3c; all over, 1.6c less 10 per cent. Minimum first 7 kw., $3; all over at 50c per kw.
Company 2—Average for our system is 4.36c. First 150-kw-hr. 4.5c; next 350 kw-hr., 3c ; all over 500 kw-hr., 2c. Minimum 75c per kw. of active heat load, but not less than $3 per month.
Company 3—First 30 kw-hr., 8c (lighting rate); next 120 kw-hr., 4c; all over 150 kw-hr., 1½c.
Company 4—Generally 2c per kw-hr. Minimum 50c per kw.
Company 5—First 150 kw.hr., 3½c; all over, 2c.
Company 6—First 150 kw-hr., 4c; all over, 2½c. Minimum for first 7 kw., $3; all over, 75c per kw.
Company 7—Schedule C. Practically 2c per kw-hr. 150 kw-hr., 3½c; balance, 2c. Minimum for first 7 kw., $3; all over, 50c per kw.
Company 9—First 150 kw-hr., 3½c; all over, 2c. Minimum, $3 for first 7 kw.; all over, 50c per kw.

Question: What is the present prevailing capacity of water heaters operating in metered service?
Answers: Company 1—3 kw. to 5 kw.
Company 2—3.4 kw. average.
Company 3—5 kw. and 3 kw.
Company 4—3 kw. and 1½ kw.
Company 5—3½ kw. and 1½ kw.
Company 6—5 kw.
Company 7—5 kw.
Company 8—4 kw.
Company 9—5 kw.

Question: What is your policy or preference in regard to heater capacities?
Answers: (1) When consumer maintains continuous hot water service in an average home?
Company 1—1½ kw.
Company 2—Low wattage.
Company 3—3 kw.
Company 4—Average 3 kw.
Company 5—Heaters with thermostats. Immersion or circulation type.
Company 6—Small capacity.
Company 7—5 kw.
Company 8—4 kw.
Company 9—1½ kw.
(2) When consumer required only intermittent hot water service?
Company 1—3 or 5 kw.
Company 2—High wattage.
Company 3—5 kw.
Company 4—4 kw.
Company 5—Circulation type.
Company 6—5 kw.
Company 7—5 kw.
Company 8—4 kw.
Company 9—5 kw.

Question: What is your annual cost of servicing or repairing water heaters?
Answers: Company 1—Very small.
Company 5—Practically nothing.
Company 6—Do not service.
Company 9—Very small.

Question: Do you charge the consumer for repairs?
Answers: Company 1—Material but not for labor.
Company 2—Actual cost.
Company 4—Time and material after first year.
Company 5—Nothing first year, then $1.50 per trip plus material.
Company 6—Do not service.
Company 7—Free during manufacturers' guarantee, thereafter free labor, material, plus 10 per cent.
Company 9—No charge first year. Thereafter material plus 10 per cent and labor free.

Summary

More than two-thirds of all the heaters reported are 4 or 5-kw. heaters. About 85 per cent of the water heaters reported are used in conjunction with electric ranges and 15 per cent where no ranges are installed. Of all the water heaters reported 87 per cent are circulation type heaters. Of the water heaters reported 58 per cent are equipped with thermostats and 2,447 of these are supplying continuous hot water service.

The average consumption of the heaters supplying continuous, automatic hot water service is 574 kw-hr. per month or nearly three times the consumption of the heaters supplying intermittent hot water service which averaged 210 kw-hr. per month.

Rates for Water Heating: All the water heaters reported are operating on standard cooking and heating schedules most of which are designed to throw the

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water heating on the 2c rate. Two companies have 1½c blocks and one a 2½c block. However, all but a few hundred of the water heaters reported are operating on the 2c rate, so that the heater supplying continuous automatic hot water service, using an average of 574 kw-hr. per month, produces a revenue of $11.48 per month. The intermittent heater using 210 kw-hr. earns $4.20 per month.

Load Factor: Where continuous hot water service is maintained the load factor is largely controlled by the heater capacity. For instance a 3-kw. automatic heater using 574 kw-hr. will have a load factor of 26½ per cent. Larger heaters will have less favorable load factors and smaller heaters more favorable, while supplying the same service at the same kw-hr. cost, since the amount of water heated determines the consumption.

TABLE I.

Company	Water heaters on metered service	Heater Size: Under 5 kw.	5 kw.	4 kw.	3 kw.	2½ kw.	2 kw.	1½ kw.	1 kw.	Under 1 kw.
1	61	..	25	....	11	..	12	13	..	..
2	360	7	113	19	86	40	69	8	16	2
3	685	..	325	....	325	..	25	..	..	..
4	138	1	13	4	47	1	13	58	..	1
5	230	..	4	4	*140	..	....	66	..	16
6	15	1	9	....	....	..	....	....	1	1
7	2,500	12	2,125	50	125	25	50	62	25	25
8	1,979	..	....	1,979	....	..	....	....	..	..
9	1,215	28	256	19	83	12	20	788	..	9
Total	7,183	49	2,870	2,075	817	78	189	995	42	54

*3½ kw.

TABLE II.

Company	Water heaters in conjunction with electric ranges	Water heaters equipped with thermostat	Heaters with thermostats supplying continuous hot water service	Circulation type heaters	Immersion type heaters	Combination tank and heaters	Clamp-on heaters
1	59	28	28	42	7	11	..
2	125	....	....	....	....	..	..
3	660	205	....	685	....	..	..
4	130	136	136	138	....	..	..
5	92	72	68	160	67	5	..
6	15	....	....	....	....	..	1
7	*2,250	2,500	1,000	2,450	....	..	..
8	1,515	....	....	1,979	....	..	..
9	1,215	1,215	1,215	800	415	..	..
Total	6,061	4,156	2,447	6,254	489	16	1

*Estimated

TABLE III.—Boiler and pipe insulation.

Company	No. installations where boilers are covered with 1-in. insulation	No. installations where boilers are covered with 2-in. insulation	No. installations where boilers are covered with 3-in. insulation	No. bare boilers	No. where hot water pipes are insulated	Standard recommendation for boiler insulation
1	50%	50%	....	1	None	2-in.
3	....	....	....	....	....	2-in.
4	....	110	2	16	....	2-in.
5	75%	23%	2%	10%	5	1-in.
6	....	....	....	3	1	2-in.
7	90%	8%	2%	30	200	2-in.
9	All	....	....	None	Few	2-in.

TABLE IV.—Sizes of Boilers recommended. Capacities in gallons.

Company	Small homes	Average homes	Large homes
1	18 to 30	30	....
2	30	....	....
3	24 to 30	30	50 to 60
4	....	30	....
5	18	24	30
6	30	40	60
7	30	30	52
9	30	40	60 to 80

Double Throw Switches: The reports show that practically all of the reporting power companies are recommending 1½ to 3-kw. heaters without double throw switches in average homes where the heater is to maintain continuous hot water service and 4 or 5-kw. heaters with double throw switches where water is to be heated intermittently only.

The double throw switch appears to be satisfactory where the heater capacity is relatively large whether or not the water is kept hot, but usually not satisfactory when heaters are smaller than 4 or 5 kw.

New Development: A new system of domestic water heating in which an automatic water heater is provided with 3 gal. of storage within itself and a limiting valve installed at the top of the tank in the line from the heater arranged so that the amount of water kept hot can be limited to 3 gal. or the entire contents of the boiler heated, is proving very popular. All these heaters reported are operating on standard cooking and heating rates, supplying continuous hot water service with a consumption of 250 kw-hr. or less.

Conclusion: Electric water heating is a success on a meter rate of 2c per kw-hr. On this rate about one-third of all the water heaters reported are supplying continuous automatic hot water service. However, the proportion of consumers maintaining continuous hot water with its desirable effect on load and revenue will, naturally, increase or decrease as the rate for such service increases or decreases.

An average size automatic water heater, say a 4-kw. heater, on a 2c rate, earns an annual revenue of $137.76 or $34.44 per kw. per year. A 3-kw. automatic water heater supplying the same service earns $45.92 per kw. per year.

Recommendations: In view of the fact that so little information was obtainable relative to load characteristics, the committee recommends that the incoming committee arrange to borrow the instruments which are now being used in the Northwest section on range load, for the purpose of obtaining more accurate information for next year's report on water heating.

Electric Domestic and Commercial Cooking

Report of Electric Range Committee, Electric Cooking and Heating Bureau, Commercial Section*

THE introduction of the electric range took place twenty years ago but it has been only in the past few years that the real value of this appliance as a load builder has begun to be appreciated. Consequently, during the last five years the majority of this business has been secured and progress made toward the enlightenment of the public as to the many advantages to be derived from the use of electricity for cooking.

Those companies actively engaged in promoting range sales have, in recent years, been gathering data on the characteristics of the load. The result is an accumulation of charts, curves and other statistics of a piece-meal nature. These have served to furnish those immediately associated in the work with valuable information necessary to most effectively handle the business but have not proved sufficiently authentic to convince a great number in the industry of its true status. Hesitancy, due to lack of these figures and charts, has been a retarding factor in the development of this field of the electrical industry in many localities.

Of particular importance, therefore, is the survey being undertaken at present in the Northwest by a special range survey committee under the auspices of the N.E.L.A. The program outlined is of such magnitude and the data to be collected so comprehensive and universally applicable that, predicting that results will substantiate figures already determined on a smaller scale, it is believed increased activity is certain to follow.

It is the purpose of this committee, therefore, not to touch upon the engineering problems presented but to

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TABLE I.—Domestic range installations only.

Central station	Ranges installed		Per cent of increase	Apt. houses using electric ranges		Per cent of increase	Average kw-hr. consumption per range
	Jan. 1, 1925	Jan. 1, 1924		Jan. 1, 1925	Jan. 1, 1924		
Cal. Ore. Pwr. Co.	1,663	1,356	22.6	26	19	37	141
Central Ariz. Lt. & Pwr. Co.	6	6	0	0	0	0	...
Coast Counties Gas & Elec. Co.	125	75	66.6	2	0	...	151
Coast Valleys Gas & Elec. Co.	170	110	54.5	0	0	0	...
Desert Pwr. & Water Co.	11	8	37.5	1	1	0	53
Elko Lamoille Pwr. Co.	36	.....	....	...	...	...	...
Flagstaff Elec. Lt. Co.	8	6	33.3	2	2	0	125
Great Western Pwr. Co.	2,774	2,060	31.8	69	53	30.2	150
Los Angeles Gas & Elec. Corp.	100	80	25	1	1	0	147
Nev.-Cal. Pwr. Co.	12	12	0	0	0	0	...
Ontario Pwr. Co.	670	620	8.1	0	0	0	215
Pacific Gas & Elec. Co.	5,715	4,359	31.1	25	21	19	150
San Diego Consol. Gas & Elec. Co.	518	433	19.6	0	0	0	168
San Joaquin Lt. & Pwr. Co.	1,700	1,400	21.4	14	12	16.6	120
Southern Ariz. Pwr. Co.	24	22	9.1	1	1	0	350
Southern Cal. Edison Co.	4,947	4,667	6.0	2	2	0	254
Southern Sierras Pwr. Co.	1,039	725	43.3	2	2	0	126
Truckee River Pwr. Co.	517	478	8.2	12	10	20	180
Turlock Irrig. District	460	130	254.0	2	1	100	180
Upper Verde Pub. Util. Co.	20	5	300.0	1	1	0	...
Vallejo Elec. Lt. & Pwr. Co.	79	71	11.3	3	3	0	153
Western States Gas & Elec. Co.	482	316	52.5	3	1	200	145
	21,076	16,939	24.4	166	130	27.7	165

confine itself to the commercial side of the business. Aside from the statistics gathered to show the progress recorded by the various member companies, the principal purpose of this report is to determine the extent to which the use of electric ranges has developed in the homes of those engaged in the industry and to investigate wiring costs in an endeavor to devise means to lessen resistance caused by this incidental expense.

In obtaining current data and statistics for the report, the committee is indebted to the power companies and manufacturers for their cooperation.

Present Status and Future Possibilities

The value of the electric range to the power companies of the West cannot be overestimated. Due to the absence of thickly populated centers in close proximity to one another, together with a generous portion of the country's water power, the central station companies in this section must look for a substantial portion of their growth by creating an ever-increasing use of their product in the homes of present and future consumers. The electric range affords almost unlimited possibilities in this regard.

Statistics gathered by a publication devoted to our industry indicate a total of 1,105,070 domestic consumers of electricity served by the utilities in the three states of California, Nevada and Arizona, as of Jan. 1, 1925. Of this number but 2 per cent have been sold the convenience of electric cookery. Table I shows, with the exception of approximately 1,000 ranges on the lines of small municipally operated plants and those of commercial companies, the total number of domestic ranges connected to lines of all companies in this section, the increase for 1924; and reported average monthly kw-hr. consumption per range on lines of various companies.

Notwithstanding the handicap placed upon some of the companies in California last year due to the water situation, some progress is to be noted. A total of 4,137 ranges were reported connected to lines of all companies in this section representing an increase of practically 25 per cent.

Included in the 21,076 ranges reported in operation as of Jan. 1, 1925, slightly less than 10 per cent are being used by a more or less transient element in the 166 apartment houses so equipped. This exerts a tremendous influence as an educational medium as does the equipment used daily by more than 10,000 pupils in the home economics departments of the 69 schools so outfitted. As a great many of the apartment house dwellers later become owners or renters of homes wherein they will desire electric ranges, so do the school girls of today become the housewives of tomorrow. Particular attention should be paid, therefore, to the increased use of electricity in the schools as well as in apartments and flats.

It is evident that the field for the use of electricity for cooking and baking has scarcely been scratched, and that concerted effort on the part of the central station companies, manufacturers, jobbers and dealers will open up almost unlimited avenues of revenue for all concerned and further raise the high standard of living already attained by the people of the West. The revenue from ranges in but 2 per cent of the wired homes in this section adds in excess of $1,000,000 annually to the income of central stations. These figures will furnish some idea of the possibilities yet to be realized. An excerpt from the report of one company shows revenue derived from total domestic lighting consumers as compared to that derived from total domestic range consumers in the same locality. Table II shows the value of this load as a revenue producer.

Those Engaged in the Electrical Industry Versus the Electric Range

An outstanding obstacle toward a greater increase in the use of the electric range can be laid at the door of the electrical fraternity itself. The indifference to their responsibility in the use of electric ranges by the employees of power companies, manufacturers, jobbers, dealers, in fact, the great majority associated in the work of our industry, is one of the problems requiring solution before the progress warranted by the superiority of this method of cookery can be made. To

TABLE II.

Comparison of revenue derived from domestic lighting consumers only with that derived from a smaller number of consumers using both lighting and cooking in the same locality.

Month	No. of domestic light cons.	Monthly rev. from domestic light cons.	Per cent increase or decrease	Monthly rev. per cons.	*No. of domestic cook. cons.	Monthly rev. from domestic cook. cons.	Per cent increase or decrease	Monthly rev. per cook. cons.
1923								
July	4,195	$7,434.00	.....	$1.77	793	$3,428.61	.....	$4.43
Aug.	4,529	7,736.65	+.041	1.71	806	3,471.51	+.013	4.31
Sept.	4,812	8,349.78	+.079	1.74	819	3,783.58	+.089	4.62
Oct.	5,172	10,874.98	+.302	2.10	832	4,584.39	+.21	5.51
Nov.	5,545	11,217.41	+.031	2.02	845	4,425.94	—.034	5.24
Dec.	5,618	12,816.73	+.143	2.28	861	5,450.41	+.23	6.33
1924								
Jan.	5,689	15,291.30	+.193	2.69	877	6,975.52	+.28	7.95
Feb.	5,735	13,372.56	—.125	2.33	892	6,255.50	—.104	7.01
Mar.	5,852	11,893.78	—.11	2.03	907	5,606.90	—.104	6.18
Apr.	5,936	11,260.82	—.53	1.90	948	5,871.16	+.047	6.19
May	6,018	11,138.44	—.011	1.85	951	5,643.90	—.039	5.93
June	6,045	9,650.70	—.133	1.60	960	5,895.07	+.045	6.14
July	6,102	9,162.71	—.051	1.50	970	5,116.77	—.032	5.28
Aug.	6,187	10,133.37	+.106	1.64	981	5,606.33	+.094	5.71
Sept.	6,251	10,802.89	+.066	1.73	992	6,005.47	+.071	6.05
Oct.	6,323	12,353.79	+.144	1.95	1,000	5,850.13	—.023	5.85
Nov.	6,409	14,363.37	+.163	2.24	1,011	7,037.48	+.203	6.96
Dec.	6,495	14,862.79	+.035	2.29	1,021	7,472.19	+.062	7.32
Average	5,717	11,262.00		1.97	915	5,471.16		5.98

\+ equals increase.
— equals decrease.
*Cooking consumers in most cases have lighting on same meter with range.

successfully sell the idea of electric cookery to the public we must first demonstrate our sincerity by adopting the electric range and other household appliances.

Very little information is to be had from the manufacturers, jobbers and dealers to arrive at an accurate check of those using ranges but surveys made in several localities showed the percentage to be less than that of the employees of central stations in the same pany.

TABLE III.—Number and percentage of power company employees using electric ranges.

Central station	No. employees using elec. ranges	Per cent employees using elec. ranges	Policy of sale to employees	Terms of payment by employees
Cal. Ore. Pwr. Co.	165	59.5	Cost plus 5%	....
Coast Counties Gas & Elec. Co.	2	1.0	Cost	Cash
Coast Valleys Gas & Elec. Co.	5	7.0	....	....
Desert Pwr. & Water Co.	4	21.0	Cost	Terms
Elko Lamoille Pwr. Co.	4	28.5	....	....
Great Western Pwr. Co.	158	17.5	Cost	Terms
The Nev.-Cal. Pwr. Co	6	....	Cost	....
Ontario Pwr. Co.	12	24.0	Cost	Terms
Pacific Gas and Elec. Co.	*255	3.0	Cost	Terms
San Diego Consol. Gas & Elec. Co.	5	5.0	Cost plus 15%	Terms
San Joaquin Lt. & Pwr. Corp.	85	4.5	....	....
Southern Ariz. Pwr. Co.	5	10.0	Cost	....
Southern Cal. Edison Co.	250	12.5	Cost	Terms
Truckee River Pwr. Co.	4	2.5	Cost	....
Turlock Irrig. District	18	24.0	Cost plus 20%	Terms
Western States Gas & Elec. Co.†	6	20.0	Cost	Terms
Vallejo Elec. Lt. & Pwr. Co.	2	20.0	Cost	Terms
Upper Verde Pub. Util. Co.	2	10.0	....	....
Total	988			

*Approximate.
†Richmond district only.

To improve the situation it is recommended that range manufacturers continue to extend to those in the industry the special discounts established in the past at stated periods. It is further recommended that this saving be passed on to the employee, by all in a position to so handle, with the added inducement of long time payment terms together with the cost of wiring spread over a period of months.

As the chief cause for lack of more universal use of the range by those in the industry is due to the large percentage occupying rented homes, it is suggested that each company work out a system of wiring, having in mind the removal of the same for reuse at some future time with the least possible loss to employee. This, of course, must meet code requirements and local regulations. After the method of wiring is thus determined it will be found that little material will be district. It was possible to obtain some figures from the power companies on this subject. These figures, together with data relative to the sales policy used in selling ranges to employees are given in Table III.

As stated above, the failing, insofar as central station company employees are concerned, is even more pronounced in the manufacturer, jobber and dealer class. In almost every instance shown in Table III the use of electric ranges by employees is encouraged by the power companies by the sale of equipment at cost on terms. In many cases the charge for wiring can be handled on a term basis through the power comwasted and that labor involved will constitute the major loss. Many employees would be in a position to reduce the labor charges by removing their own wiring upon vacating the premises. With these facts fully understood and the assistance of the company in the matter of terms on the original installation, a great many additional users in the industry should result.

One method suggested calls for screwing conduit containing service wires to the outside of the building without molesting old service; the addition of a switch and cutout in the meter box in such manner as to be easily removed and without including lighting circuits on the same meter with the range. The range circuit from service switch to range can be attached in such a way as to be easily salvaged and connection to range made by means of flexible conduit through the floor to the switch and made fast to the range instead of the wall. This would necessitate metering the range separately from the lighting load. If heavy enough service is run to carry lighting circuits in addition to range, or if one-meter system is desired, the lighting circuits could be cut over to register through a combination meter and wiring could be left so that connections could be replaced in case of the removal of range wiring.

After the adoption of a liberal sales policy and a minimizing of resistance due to wiring expense in rented houses, the problem is by no means solved. A constant sales effort on the part of each company without giving an impression of coercion must be applied. One very productive method is by the introduction of competitive campaigns between departments, cities, divisions, etc., and the interest thereby kept focussed on the issue. A well devised scheme for this purpose with provisions for posting results at frequent intervals is desirable. This same plan should be put into effect on a scale to conform to the smaller organizations of manufacturers, jobbers and dealers.

This committee believes this issue vital to the industry and that the solution, on account of varying circumstances, must remain in the hands of each individual company. Recommendations, therefore, cannot but cover a few general points. Improvement can and should be made, however, and it is strongly urged that serious thought be given the matter and a conscientious effort made to overcome this deficiency as quickly as possible.

Recommendation is made that the incoming range committee continue the study of this problem and report progress made up to the time of their report with further suggestions based upon the conditions as they will have then developed.

Merchandising Ranges

Although less than one-half of the power companies in this section are actively pushing the sale of ranges, all of the larger ones are undertaking the work with plans for greatly increased effort this year. Aggregate results for 1924 are somewhat disappointing, but in those localities where activity was not curtailed the percentage of increase is more satisfactory. Table IV

TABLE IV—Sales acceptance and degree of penetration attained by several companies.

Central Station	Active in range sales	Selling policy	No. ranges per salesman sold monthly—1924	Average monthly sales per salesman expected	Approximate per cent domestic cons. using ranges
Cal. Ore. Pwr. Co.	Through dealers	List	No salesmen	10	13.3
Coast Counties Gas & Elec. Co.	Yes	Cost plus 15%	5	5	01.1
Coast Valleys Gas & Elec. Co.	Yes	.....	7	8	02.6
Great Western Pwr. Co.	Yes	Cost plus 20%	8	12	06.3
Los Angeles Gas & Elec. Corp.	No	Do not sell	No salesmen	.....	....
Ontario Pwr. Co.	Yes	.....	.....	15	00.1
Pacific Gas and Elec. Co.	Yes	Cost plus 20%	9.4	12.5	01.8
San Diego Consol. Gas & Elec. Co.	Yes	Cost plus 20%	14	12	01.3
San Joaquin Lt. & Pwr. Co.	Yes	Cost plus 20%	10	10	03.4
Southern Cal. Edison Co.	Yes	.....	.....	20	02.4
Southern Sierras Pwr. Co.	Yes	Cost plus 26%	10	8	09.7
Truckee River Pwr. Co.	No	Do not sell	None	.....	00.5
Turlock Irrig. District	Yes	Cost plus 20%	Entire company-29	Entire company-29	15.8
Vallejo Elec. Lt. & Pwr. Co.	Yes	Cost plus freight and cartage	No salesmen	..	01.6
*Western States Gas & Elec. Co.	Yes	Cost plus 28%	9.8	10	01.6

*Richmond district only

throws some light on the sales resistance encountered in the territories served by some of the larger power companies as well as approximate percentage of domestic consumers using electric ranges.

TABLE V.—Range installation costs—P. C. E. A. companies

Central Station	Average charge for wiring from termination of power company drop to range	By whom installed
Cal. Ore Pwr. Co.	$30 to $45	Contractor-dealer
Coast Counties Gas & Elec. Co.	$54	Contractor-dealer
Coast Valleys Gas & Elec. Co.	$50	Contractor-dealer
Desert Pwr. & Water Co	$45	Contractor-dealer
Flagstaff Elec. Lt. Co.	$15	Not reported
Great Western Pwr. Co.	$35 to $80	Contractor-dealer
Los Angeles Gas & Elec. Corp.	$35	Contractor-dealer
Ontario Pwr. Co.	$20	Contractor-dealer
Pacific Gas and Elec. Co.	$60	Contractor-dealer
San Diego Consol. Gas & Elec. Co.	$35 to $60	Contractor-dealer
San Joaquin Lt. & Pwr. Corp.	$75	Contractor-dealer
Southern Cal. Edison Co.	$50	Contractor-dealer
Southern Sierras Pwr. Co.	$40	Contractor-dealer
Southwestern Ice & Cold Storage Co.	$30	Contractor-dealer
Turlock Irrig. District	$45	Central station
Upper Verde Pub. Util. Co.	$25	Contractor-dealer
Vallejo Elec. Lt. & Pwr. Co.	$45	Central station
Western States Gas & Elec. Co.	$60	Contractor-dealer

Policies of sales adopted in almost every instance call for the sale of ranges at less than list prices and in most cases either for cash or on time (carrying charge is usually added for installment purchases). Many developments of the past year and those under way at present are affecting the sales channels for this product. New ranges have appeared on the market and still others are being developed. Most of these are products of old established stove manufacturers. As a result there has been an awakening on the part of stove houses and retail specialty stores as to the possibilities in this new field.

Practically all central-station companies are making a sincere effort to encourage the contractor-dealer in the sale of ranges. This has resulted in increased dealer activity, but much more intelligent and persistent effort is required along these lines before he will become the important factor in the distribution of electric ranges, to which his position in the merchandising chain would seem to fit him. An undercurrent of activity and interest is prevalent which would seem to indicate that this business will soon be sought by stove houses and retail specialty stores. Immediate consideration and greater activity on the part of the electrical dealer would seem advisable to avoid the diversion of this ever-increasing business from its present channel.

This committee believes the situation now demands a policy of sales at manufacturers' lists, except in certain quantity lots. Such action, because of additional lines, the interest built up and the appreciable increase in unsolicited business noticed, it is believed, will only temporarily retard the volume of sales and will lay a firm foundation for a gradual and permanent upward curve in future range sales.

The slightly greater sales resistance created by an advance in prices will be offset soon by the increased activity on the part of dealers and stove retailers and,

TABLE VI—Range installation for various cities

Central station	Location	Average cost to cons. for wiring ranges	Type of wiring		By whom installed	Street or alley distribution system	Size of carrying wires for range circuit required	Switch requirements at range	Is separate circuit on separate cut-out required?	Type of switch		Average capacity of ranges reported on
			Main service	Range circuit						Main switch	Range switch	
Birmingham Elec. Co.	Birmingham, Ala.	$30	Conduit or K&T	Conduit or K&T	Dealer	Both	100% cap.	None	.....	.....	.....	8 kw.
Southern Cal. Edison Co.	Los Angeles, Cal.	$50	Conduit	Conduit	Dealer	Both	#8 wire	None	Yes	Ext. op.	None	Up to 9 kw
Great Western Power Co.	San Francisco, Cal.	$80	Conduit	Conduit	Dealer	Street	100% cap.	Yes	Yes	Ext.op.	Ext. op.	7 kw.
Pacific Gas and Elec. Co.	San Francisco, Cal.	$80	Conduit	Conduit	Dealer	Street	100% cap.	Yes	Yes	Ext. op.	Ext. op.	7 kw.
Jefferson County Pwr. and Lt. Co.	Golden, Colo.	$30 to $40	Conduit or K&T	Conduit or K&T	Power company	Both	#6 wire	60-amp.	.....	.....	.....	.....
Georgia Ry. & Pwr. Co.	Atlanta, Ga.	$42	Conduit	Conduit	Dealer	Street	100% cap.	Yes	Yes	Ext. op.	Ext. op.	6.5 kw.
Savannah Elec. & Pwr. Co.	Savannah, Ga.	$30	K & T	K & T	Dealer	Alley	100% cap.	Yes	Yes	Ext. op.	Ext. op.	5 kw.
Idaho Pwr. Co.	Boise, Idaho	$32	Conduit	Conduit	company & dealer	Alley	100% cap.	None	Yes	Ext. op.	None	5 kw.
Commonwealth Edison Co.	Chicago, Ill.	$90	Conduit	Conduit	Dealer	Both	100% cap.	Yes	Yes	Ext. op.	Ext. op.	6 kw.
Central Illinois Pub. Service Co.	Springfield, Ill.	$20 to $30	Conduit or K&T	Conduit or K&T	Dealer	Both	#6 wire	None	No	Safety knife	None	.....
Wabash Valley Elec. Co.	Clinton, Ind.	$25 to $30	Conduit	Conduit or duplex	Optional	Alley	50-amp. cap.	None	Yes	Ext. op.	None	4 to 7 kw.
Merchants' Heat & Lt. Co.	Indianapolis, Ind.	$60	Conduit or BX	Conduit or BX	Dealer	Alley	100% cap.	Yes	Yes	Ext. op.	Ext. op.	6 kw.
Indiana & Michigan Elec. Co.	South Bend, Ind.	.....	Conduit	Conduit	Dealer	Both	100% cap.	None	Yes	Ext. op.	None	6 kw.
United Appliance Co.	Evansville, Ind.	$50	Conduit	Conduit	Dealer	Alley	100% cap.	Yes	Yes	Ext. op.	Ext. op.	7.5 kw.
Iowa Ry. & Lt. Co.	Cedar Rapids, Iowa	$20	Conduit	Conduit	Power company	.....	#6 wire	None	.....	.....	None	8 kw.
Keokuk Elec. Co.	Keokuk, Iowa	$35	Conduit	Conduit	Dealer	Alley	100% cap.	Yes	Yes	Ext. op.	Ext. op.	.....
Kansas Gas & Elec. Co.	Wichita, Kan.	$40 to $45	Conduit	Conduit	Both	Both	100% cap.	Yes	Yes	Ext. op.	Ext. op.	Up to 7 kw.
Paducah Elec. Co.	Paducah, Ky.	$50	Conduit	K & T	Dealer	Street	100% cap.	None	No	Ext. op.	None	.....
The Edison Elec. Ill. Co. of Boston	Boston, Mass.	$67 50	Conduit	BX	Dealer	Both and underground	100% cap.	Yes	Yes	Either	Either	.....
Haverhill Elec. Co.	Haverhill, Mass.	$65	Conduit	Conduit	Dealer	.....	#4 wire	Yes	.....	Ext. op.	Ext. op.	8 kw.
Consumers Power Co.	Jackson, Mich.	$45	Conduit	K & T	Dealer	Street	100% cap.	None	Yes	Ext. op.	None	7 kw.
Northern States Pwr. Co.	Minneapolis, Minn.	$40	Conduit	Conduit	Dealer	Both	100% cap.	None	Yes	Ext. op.	None	5.5 kw.
Marysville Elec. Lt. & Pwr. Co.	Marysville, Mo.	$20	Conduit	Conduit	Power company	Both	100% cap.	None	Yes	Ext. op.	None	6 to 7 kw.
Union Elec. Lt. & Pwr. Co.	St. Louis, Mo.	$35	Conduit	Conduit	Both	Both	100% cap.	Yes	No	Ext. op.	Snap	Up to 7.5 kw.
Missoula Pub. Service Co.	Missoula, Mont.	$40	Conduit	K & T	Dealer	Alley	100% cap.	None	No	Ext. op.	None	.....
Central Power Co.	Grand Island, Neb.	.....	Either	Either	Both	Alley	Less than cap	None	Yes	Ext. op.	None	.....
Cleveland Elec. Ill. Co.	Cleveland, Ohio	.....	Conduit	Either	Dealer	Both	100% cap.	Yes	Yes	Either	Either	.....
Union Gas & Elec. Co.	Cincinnati, Ohio	$1 per ft.	Conduit	Conduit	Dealer	Street	100% cap.	None	Yes	Ext. op.	None	7 kw.
Northwestern Elec. Co.	Portland, Ore.	$35	Either	Either	Dealer	Both	100% cap.	None	Yes	Either	None	8 kw.
Portland Elec. Pwr. Co.	Portland, Ore.	$35	Conduit	Conduit	Dealer	Street	100% cap.	None	Yes	Either	None	7.5 kw.
Pennsylvania Pwr. & Lt. Co.	Allentown, Pa.	$90	Conduit	Open	Dealer	Both	100% cap.	Yes	Yes	Ext. op.	Ext. op.	5 kw.
Duquesne Lt. Co.	Pittsburgh, Pa.	$75 to $150	Conduit	Conduit	Dealer	Both and underground	100% cap.	Yes	Yes	Ext. op.	Ext. op.	6 to 7 kw.
Scranton Elec. Co.	Scranton, Pa.	$75	Conduit	Conduit	Dealer	Both	100% cap.	Yes	Yes	Ext. op.	Ext. op.	6 kw.
Narragansett Elec. Lt'ng Co.	Providence, R. I.	.....	Conduit	Conduit	Dealer	Street	100% cap.	None	Yes	Service box	None	7 kw.
Houston Lt'ng & Pwr. Co.	Houston, Tex.	$23 to $33	Conduit	Conduit	Dealer	Both	100% cap.	Yes	Yes	Ext. op.	Either	7 kw.
Utah Pwr. & Lt. Co.	Salt Lake Cy., Utah	$20 to $50	Conduit	Conduit	Dealer	Both	100% cap.	None	Yes	Ext. op.	None	7 kw.
Virginia Western Pwr. Co.	Clifton Forge, Va.	.....	Either	Either	Power company	Street	100% cap.	None	Yes	Ext. op.	None	.....
Puget Sound Pwr. & Lt. Co.	Seattle, Wash.	$45	Conduit	Conduit	Dealer	Both	100% cap.	None	Yes	Ext. op.	None	7.5 kw.
City of Seattle	Seattle, Wash.	$40	Conduit	Conduit	Dealer	Both	100% cap.	None	Yes	Ext. op.	None	8.5 kw.
Washington Water Pwr. Co.	Spokane, Wash.	$41 80	Conduit	Conduit	Dealer & company	Both	100% cap.	None	Yes	Either	None	8 kw.
Madison Gas & Elec. Co.	Madison, Wis.	.....	Conduit	Conduit	Dealer	Street	75% cap.	None	Yes	Ext. op.	None	.....
Wisconsin Pwr. & Lt. Co.	Madison, Wis.	$30	Conduit	Conduit	Power company	Both	100% cap.	Yes	Yes	Safety	Optional	6 to 9 kw.
Natrona Power Co.	Casper, Wyo.	$25 to $35	Conduit	Conduit	Dealer	.....	# 8 wire	60-amp.	.....	.....	.....	8 kw.
Sheridan County Elec. Co.	Sheridan, Wyo.	$20	Conduit or BX	Conduit or BX	Power company	Alley	100% cap.	Yes	Yes	Ext. op.	Ext. op.	5 kw.

because of the latitude in merchandising methods a greater margin of profit would permit. Installment sales undoubtedly would increase and certain models would replace in popularity others now generally sold, but the policy would be sound and healthy and create greater sales in the near future.

These recommendations do not presuppose the elimination of the central-station companies from the selling field. In fact, enlargement of the scope of the work and greately increased activity along with the retailing dealers are believed to be necessary. From the standpoint of demand, for the best interests of dealer and power company, it is considered the permanent activity of central-station companies in the sale of all electrical appliances (both lamp-socket and especially wired) is advisable. At least the successful outcome of the proposed policy would depend largely at first on the redoubled effort of the central stations which a list sales policy would support.

Consideration of this important proposed change in the policy of sales by all power companies, dealers and manufacturers is urged with the idea in mind of generally adopting and supporting the plan.

Range Wiring Data

While numerous surveys into the cost of electric ranges indicate the initial selling price does affect sales to a degree, it has been determined that this does not present the obstacle which is created because of the wiring or installation costs incident thereto. Code requirements, stringent in some respects, together with rules put into effect by local authorities have not tended to lessen this burden. The seriousness of this problem cannot be denied and a solution is sought by all interested parties. Table V was prepared from figures furnished by companies in this section as to wiring costs for installing ranges in their territory.

It is recommended that information on load characteristics be gathered at as early a date as possible from the reports as they come out from the Northwest section survey and presented by the incoming range committee to the wiring committee of the N.E.L.A. with request that attempt be made to obtain modification in the present code requirements of the National Board of Fire Underwriters.

The changes in the code recommended by this committee are:

(1) Elimination of Rule 1602 D requiring switch in sight of range (one externally operated switch and fused cut-out at meter location being considered sufficient).

(2) Modification of code to permit use of three No. 8 wires for range circuit on ranges of a capacity to and including 9 kw.

(3) Elimination of Rule 1602 E so as to permit protection of a range and water heater by one set of fuses and one switch.

It is further recommended that local electrical authorities be acquainted with the experiences of other companies where ranges are installed under less stringent regulations with entire satisfaction and safety. It is suggested some relief might be had in most of the cities in this section by gaining permission of local authorities to:

(1) Modify rules to permit knob and tube wiring for ranges in all one family dwellings.

Reports were requested from numerous cities throughout the United States as to wiring costs, method of installation, nature of distribution, etc. Information received from these inquiries is tabulated in Table VI to assist in presenting this matter.

Cost of Electricity for Operating Electric Ranges

Reports indicate that the once all-important point of discussion, i.e., the operating cost of an electric range, while it continues to be brought up, is easy of explanation and does not usually present an obstacle to the sale of the equipment. The reason for this is a greater familiarity on the part of the public occasioned by the increased use of electric ranges.

Since the question continues to be raised, it must be met with more convincing arguments than mere generalities. One company in the southern part of California meets this inquiry with the statement that the average bill per month for 4,000 consumers is $4.59. Another California company has figures showing an average monthly bill per range user of $4.17 for a large number of ranges.

The committee's investigation has revealed a surprising lack of vital statistics pertaining to the cost of operating electric ranges. Those companies successful in the development of this class of business have reported the records of costs of operating the various appliances connected to their lines of the greatest assistance to the sales department. It is strongly urged that a more complete record be kept and made available for the advancement of the business in the future. The dealer is particularly interested and is relying on the power company to supply him this data. A compilation of data as to cost of operation, together with description of equipment, size, number in family, etc., will prove invaluable and worth many times the expense and effort necessary to gather.

Some very salient facts on the cost of operation of electric ranges can be gleaned from Table I. Seventeen of the reporting companies have supplied information as to the average monthly kw-hr. consumption for ranges on their lines. The total number of ranges reported in operation Jan. 1, 1925, on the lines of these seventeen companies is 20,832, and the average monthly kw-hr. consumption per range for this number is 165. At a rate of 3c per kw-hr. this consumption in dollars and cents is $4.95. This is conclusive evidence of the unquestionable practicability of electric cookery from the operating cost standpoint alone without considering the many savings in time, labor, cleanliness and convenience.

Demonstrating and Servicing Ranges

A range is not sold when a customer places his or her signature on the contract, nor yet when it is delivered to the home. A real sale is consummated when the equipment has been connected and placed in use with entire satisfaction. It should be remembered that in changing to an electric range from the use of one using fuel the housewife is apt to feel she is handling a more or less mysterious substance and her methods may prove wasteful unless necessary and simple instructions are given.

An efficient demonstrator should appear in the home as soon as practicable after the range is connected, to familiarize the new user with the essential points necessary to its satisfactory and economical operation. This visit should be followed up at intervals with telephone calls or visits to show the consumer the seller's interest in the success of her new appliance.

As it is natural to recommend the things which are giving satisfaction, it will be found that a prompt and well executed follow-up by a demonstrator is desirable from still another angle. A satisfied and enthusiastic new owner will interest her neighbors and friends more readily than will be the case after the appliance has been in for some time and is looked upon as commonplace. The demonstrator can insure this support in the beginning and its continuance to a degree by periodical calls after the range has been in use for a long time.

Of even greater importance than proper demonstration is the matter of servicing and the policy of providing labor and repair parts for ranges. It is desirable, to further popularize the appliance, that as little burden as possible be placed upon the consumer in the way of charges for labor and parts used. Prompt and efficient maintenance work is necessary to prevent an antagonistic impression toward the equipment should it become inoperative.

A study of this subject has caused this committee to arrive at the conclusion that the further popularization of the range demands a liberal policy of service by the central station supplying electricity therefor, as well as full cooperation in this regard from the dealer who makes the sale and the manufacturer whose product is sold. The practice generally used is endorsed and its continuance, while the development is in its present stage, recommended. This policy of service supplies to the consumer free of charge, during the first year, all parts (parts for first year supplied under manufacturer's guarantee) and labor involved for ordinary outages. After expiration of guarantee period labor continues to be furnished without charge but repair parts required are charged at power company's cost or cost plus a small percentage for handling. Encouragement for the dealer is provided in this manner also by removing from him most of the burden of service.

Commercial Electric Cookery

In considering the subject of electric heavy duty cooking and baking equipment, manufacturer, jobber, central station and dealer were found to be interested

parties to the development of this business. A study of the matter from the angle of any of these agents brings forth many interesting facts and figures. One fact outstanding is that heavy duty equipment, similar to most other large power consuming devices, depends upon the central station primarily for the activity which causes the desired movements from the manufacturer to the consumer. If such sales have not been progressing as energetically as might be hoped then it remains necessary to show that this class of load is desirable for the power company. It is presumed, of course, that the central-station company's activities will not cover the actual merchandising of this equipment but will assist in its promotion through dealers and other retail outlets. The margin of profit is relatively small and dealer could not afford to handle the business unless fully protected.

TABLE VII—Heavy duty ranges reported in use on lines of companies in this section.

Central station	Connected Jan. 1, 1925	Connected Jan. 1, 1924	Percentage of increase	Average monthly kw-hr. consumption per range	Average monthly revenue per range
Cal. Ore. Pwr. Co.	17	11	54.5	3,833	$50.60
Great Western Pwr. Co.	11	5	120.0	2,600	52.00
Pacific Gas and Elec. Co.	3	3	0	1,833	31.10
San Diego Consol. Gas & Elec. Co.	1	1	0	3,500	90.00
San Joaquin Lt. & Pwr. Corp.	4	4	0	8,000	123.75
Southern Cal Edison Co.	No record	No record	....	....	....
Turlock Irrig. district	2	....	....	1,700	18.00

The industrial application of electrical energy represents a very great field and in this classification few applications are so profitable and attractive as the heavy duty cooking and baking load. It has been estimated that if all fuel equipment in use in the United States were to be replaced by electric heavy duty equipment, the central stations would be called upon to furnish approximately 12,500,000 kw-hr. additional per day. On the other hand, if 15 per cent of all fuel installations were converted to electric, within five years the sales would be increased about 2,000,000 kw-hr. per day. Table VII shows the little progress made in this direction.

The field for the use of heavy duty electric equipment includes bakeries, hotels, restaurants, cafeterias, lunch rooms, tea rooms, hospitals, schools, clubs, ships, Y.M. C.A.'s, Y.W.C.A.'s, apartment hotels, industrial plants, penal institutions, U. S. government ports, etc. With the exception of new installations, these various prospects have equipment which will be partly or entirely replaced in the next several years.

Of all heavy duty equipment the bake oven, being the oldest, is perhaps best known and most generally used. While it is known there are considerably more heavy duty ranges in use than those reported in Table VII, several ranges are used in Yosemite Valley and by commercial companies generating their own electricity, a considerably larger number of bake ovens are to be found.

An interesting report covering a survey of fifty installations of various units of equipment ranging from a 3-kw. griddle to an 80-kw. bake oven showed the following facts:

Merchandise sales price of equipment	$85,320	
Jobbers' profit	8,532	
Merchandise profit	12,789	
Electric contractor received for material and labor	14,580	
Connected load of equipment		1,854 kw.
Average load demand		863 kw.
Cost to central station for line service, transformers and meters	14,650	
Annual income to central station for current consumed	42,000	

A check of installations showed that equipment operated at a 70 per cent off-peak load.

The bake oven load operates 8 hours per day on an average and often operates 16 to 18 hours in each 24. The off-peak characteristics of this load are manifest, especially in the case of a combined cooking and baking load on a rate where regulated demand tends to reduce the consumer's bill. Ranges, broilers, griddles, waffle irons, egg broilers, steam tables, coffee urns and various special devices are often found in a combined installation with bake ovens. Actual surveys have developed that the power factor is often as high as 70 per cent and that the operating demand averages from 50 to 70 per cent of the connected load.

Dealers almost generally state the margin of profit on most lines of heavy duty equipment is far too little and that the price at which it is being retailed is out of line when compared with fuel-consuming equipment designed for the same purpose.

Testimonials from users agree that the electric equipment is superior for the following reasons: cleanliness; produces uniformly better products; affords improved working conditions; requires less attendance; requires less floor space; results in less shrinkage of food; means less spoilage and far more convenience.

The Growing Importance of Electric Air Heating

Report of Electric Air Heating Committee, Electric Cooking and Heating Bureau, Commercial Section*

THE use of electricity for the heating of air is being rapidly extended. A check of the sales of electric heater manufacturers reveals this fact. Salesmanship alone is not responsible. If there were no merit to this method of heating, sales would decline as knowledge of its defects became known.

The heating of air by this means is of growing importance, let us consider its advantages from the standpoints of both users and the central stations. To be successful, it must prove a source of real benefit to the user and of ultimate profit to the companies supplying the necessary energy. Much information is already available on this subject. That there are hundreds of users of this form of electric service who are thoroughly pleased with it, and that certain power companies have proved the load to be desirable cannot be denied by anyone that is fully informed.

Local conditions, including climate, prevailing temperatures, generating and distributing costs, habits of the users, etc., have a broad influence on the growth of the business.

The colder winter climate of the Middle West and Eastern states is less favorable to the use of electric heat than the milder climate of the Southern and Pacific Coast states. Sections enjoying low steam generating costs or favorable water power developments where costs of generation, transmission, and distribution of current are not excessive are in better position to benefit from the service than those less fortunately situated. It is not strange, therefore, that electric air heating has had its inception and enjoyed its most rapid expansion on the Pacific Coast. It has been proved in a number of instances that its profitable use is not limited to that section of the country.

Any well constructed building can be comfortably heated with electricity regardless of its location or the prevailing temperatures. Decision regarding its use must be based on a comparison between its relative advantages and cost on one side and cost of fuel on the other. There are electric service customers in every community who are able and anxious to use electric heat even where the cost has been found to be very much higher than fuel.

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With these facts in view, the following paper was prepared to show:

1. The advantages of electric heat to the user.
2. A method of estimating the size of heaters required for different types of buildings.
3. A method of calculating energy consumption.
4. Some actual data on energy uses in existing installations.

Advantages of Electric Heat

Some of the features of this form of heating which carry a strong appeal to the user may be outlined as follows:

Healthfulness: It does not vitiate the atmosphere either by burning up the oxygen in the air or by throwing off poisonous fumes.

Cleanliness: No smoke, soot, grease, dirt, moisture or disagreeable odors are given off because no combustion takes place.

Convenience: No fuel or ashes have to be stored or handled. No fires have to be lighted or otherwise tended. Temperature may be controlled manually or automatically. Heaters may be moved from place to place or permanently mounted where they render the best service. Heat is instantly available without the delay commonly experienced with steam, hot water and other heating systems. Only such portions of the building that are occupied need be heated.

Safety: When heaters have been designed to pass the inspection of the National Board of Fire Underwriters and have been installed properly there is no danger of fires, explosions or poisonous fumes.

The following are a few of the types of installations which are proving successful:

All Electric Homes: Due to the cost and difficulty of obtaining competent servants, many families in modest circumstances make their homes of from five to eight rooms all electric, including lighting, cooking, water-heating, air-heating and appliances. In such cases the housewife can readily do the daily tasks herself without great exertion. The total yearly cost for such electrically equipped homes averages from $175 to $325 per year where the temperature does not go below 20 deg. F. and electricity is available at an average rate not exceeding 2½c per kw-hr. This amount is well within the range of a large class of people, when the saving in other ways is taken into consideration.

All Electric Apartments: Apartment house owners have come to realize the advantage of electric heating which eliminates the services of a janitor and the necessity of operating a central heating system continually for the convenience of a few tenants who might require almost constant heat. Electric heat is available to each tenant at any hour that they might require it, with the advantage of just paying for the amount which they need. Energy for these apartments is usually purchased on a master meter and resold to the tenant on a sub-meter. In this way a low average rate is earned. Some apartment house owners sell for a lower rate than that which they pay but are justified in doing so inasmuch as all attendant and repair charges are eliminated.

Hotels: A number of hotels have been equipped electrically with the result that they are giving entire satisfaction where a sufficient capacity of the proper kind of heaters has been installed to take care of the radiation losses of the building. It is usual in making an installation in a hotel to install the distribution panel controlling each heater in the office so that the clerk in charge can turn on the heater as soon as the room has been let. The heater is then operating by the time the occupant arrives in the room. The switch can also be pulled when the key is returned to the desk if so desired.

Schools: Safety and automatic temperature control are very important factors in school work. Schools are heated but a few hours per day and five days per week, with many holidays and vacation periods resulting in low operating costs as janitors are not required for the operation of electric heating systems. Oftentimes members of the staff wish to spend extra time after school hours and holidays. In these cases they can heat the individual room which they are occupying without the necessity of operating the entire plant. The initial cost of electric heating systems in this type of building is usually much lower than that of other heating systems. This is an added feature as money for school buildings is not readily available. In one instance the saving in the installation alone was sufficient to pay the cost of electrical energy for a period of 10 years, not taking into consideration interest on investment, cost of fuel, janitor service and depreciation of plant.

Churches: Buildings of this description require heat but a few hours per month with the result that they must have a system which will quickly heat the whole or any portion of the building. The low cost and flexibility of electric heating systems are particularly adapted to this class of building.

Offices: Employers are recognizing the advantage of supplying proper heating systems to their employees. Electric heating systems can be regulated uniformly to the temperature where employees work to the highest efficiency. Pure air with uniform heat and proper ventilation without drafts will increase office efficiency from 10 to 25 per cent.

Calculation of Heat Capacities

In making calculations as to the size of heaters required to create and maintain proper temperatures, the following must be considered:

1. Area of exposed glass.
2. Area, construction and exposure of outside walls.
3. Area, construction of inside walls and temperature of adjoining rooms.
4. Area, construction of floor and conditions under floor.
5. Area, construction of ceiling and whether attic or floor above.
6. Volume of air in room and number air changes required per hour.
7. A study of air leakage should be made as this increases the number of air changes.

High temperature radiant reflector type heaters primarily are adapted to heating limited areas rather than for uniformly raising the room temperature and as the calculations for that type of heating are entirely different from those involved in heating by convection air currents. The following discussion is limited to the subject of convection air heating only.

As the majority of electric heaters are rated in watts all radiation losses will be given in watts rather than in B.t.u. One watt-hour is equivalent to 3.412 B.t.u.

Table I computed from reliable sources gives the watts lost by radiation per sq. ft. of surface of different building materials for each 10 deg. F. difference in temperature between that of the room to be heated and the surrounding air.

To calculate the volume of air, multiply the cubical contents of the room by the number of air changes required per hour.

In residences it is customary to calculate one change of air per hour but where there are many leaks around doors and windows this should be increased to two.

In schools, churches, theaters, halls, shops, etc., the law requires 30 cu. ft. of fresh air per minute per person, but as each occupant of the room gives off a certain amount of heat, it is only necessary to figure on the heating of from two to four changes per hour according to the number occupying the room.

Where sides of buildings are exposed to winds 10 to 25 per cent should be added to the radiation losses of the surfaces exposed. Sides exposed to winds are no colder than those not exposed but due to wind pressure the air leakage is greater thus increasing the air changes.

When buildings are only heated intermittently with long intervals of non-heating, capacity of heaters should be increased at least 10 per cent. Never install under-capacity heaters as over-capacity heaters will ensure greater economy and more satisfactory service.

The following example indicates the method of determining the size of heaters for different types of buildings:

Method Used

Living room 14 x 30 ft. with 9 ft. ceiling, having two outside walls, 20 ft. wall exposed to winds. Glass area 75 sq. ft. Frame construction, plastered inside, boarded and plastered outside. Double wood floor, plastered ceiling, no floor above. One air change per hour. Difference between outside and required room temperature 30 deg. F.

Refer to Table I under 30 deg. F. temperature difference in order to determine the watts lost per sq. ft. for each particular surface.

The following gives the method of making calculations:

Glass area.....× watts lost per sq. ft. =
Outside wall (less glass area).....× watts lost per sq. ft. =
Inside wall area.....× watts lost per sq. ft. =
Floor area.....× watts lost per sq. ft. =
Ceiling area.....× watts lost per sq. ft. =
Volume room × air changes per hour × watts required per cu. ft. .....=
Allowance for exposed areas.....=

Total watts required.....=

Example 1

Surface	Area sq. ft.	Watts Lost Per sq. ft.	Total Watts Lost
Glass	75	× 9	675
Outside wall	(14 ÷ 20) × 9—75	× 3.9	900.9
Inside wall	(14 ÷ 20) × 9	× 1.2	367.2
Floor	(14 × 20)	× .75	210
Ceiling	(14 × 20)	× 3	840
Air	(14 × 20 × 9 × 1	× .162	408.24
Exposed area	(20 × 9) × .25	× 3.9	175.5
Total watts required			3,576.84

It will be noted that the watts required in this room are 1.42 per cu. ft.

In making the calculations for residence heating each room should be figured separately. However for quick estimating it is safe to figure .5 watts capacity for each 10 deg. F. difference in temperature between room and outside air. This rule does not hold true, however, under abnormal conditions or where the volume is less than 1,000 or greater than 5,000 cu. ft. As the volume increases the watts required per cu. ft. will become less. This is due to the radiating surface not being increased in direct proportion to the volume.

Applying this rule to a normal room (14 x 14 x 9 ft.) with a temperature difference of 40 deg. F. it would require 2 watts per cu. ft. or a total of 3,528 watts.

Example 2

Office Building: 40 x 60 ft. four stories high, 12 ft. high between floors, four outside walls, construction 12 in. concrete. Glass area 4,000 sq. ft., first floor wood on concrete, composition roof with plastered ceiling, two air changes required per hour, temperature difference between outside and inside room temperature 40 deg. F.

Note: In calculating the heat required for office buildings only the first story floor and upper story ceiling are taken into consideration. All partitions are also neglected as it is customary to heat the entire building at one time.

Refer to Table I in order to get the radiation losses for 40 deg. F. temperature difference.

Surface	Area	Watts Lost per sq. ft.	Total Watts Lost
Glass	4,000	× 12 =	48,000
Outside wall (less glass)	5,600	× 4.4 =	24,640
First story floor	2,400	× 1.6 =	3,840
Upper story ceiling	2,400	× 4.0 =	9,600
Air	115,200 × 2 ×	.216 =	49,766
Total watts required			135,846

In order to determine the capacity of the heaters required for the second and third floors, subtract the radiation losses of the first story floor and the fourth story ceiling from the total and then divide by the number of floors, as follows:

Total capacity of heaters in watts		135,846
Less radiation loss first story floor	3,840	
Radiation loss fourth story ceiling	9,600	13,440
Capacity to be divided equally between four floors		= 122,406
Capacity of heaters required for second and third floors		30,601.5 watts
Capacity of heaters required for first floor		34,441.5 watts
Capacity of heaters required for fourth floor		40,201.5 watts

The size of heater for each office can then be proportioned according to the size of office. Allowance should be made for extra radiation losses in corner offices. It is always good practice to check a few offices separately, but in so doing all partitions can be neglected.

It is often necessary to compare electric heater sizes with those of steam or hot water radiators for the same building and while it is a known fact that radiators vary according to construction, surface of heater and pressure the following will give a fair average:

1 sq. ft. of steam radiation at 4 lb. pressure.....= 70 watts
1 sq. ft. of steam radiation at 10 lb. pressure.....= 80 watts
1 sq. ft. of hot water radiation at 180 deg. F.....= 45 watts

Method of Calculating Energy Consumption

The records of the nearest weather bureau will give the hourly temperature for the year. For rough calculations the mean monthly temperatures during each of the heating months as averages over several years, may be taken. To estimate the consumption for any month, subtract this mean temperature from the desired temperature and divide by the maximum temperature rise figured for the heater. Multiply the heater size by this factor and by the number of hours required to heat.

As an example, an installation is figured to give 40 deg. F. temperature rise (30 deg. F. to 70 deg. F.) and the mean temperature for a given month is found to be

TABLE I

Nature of Surface	Watts lost per sq. ft. of surface for varying temperature difference expressed in degrees F. 10 deg.	20 deg.	30 deg.	40 deg.	50 deg.	60 deg.	70 deg.
Single glass	3.0	6.0	9.0	12.0	15.0	18.0	21.0
Double glass	1.7	3.4	5.1	6.8	8.5	10.2	11.9
Single skylight	3.5	7.0	10.5	14.0	17.5	21.0	24.5
Double skylight	1.8	3.6	5.4	7.2	9.0	10.8	12.6
8-in. Brick wall	1.3	2.6	3.9	5.2	6.5	7.8	9.1
12-in. Brick wall	.9	1.8	2.7	3.6	4.5	5.4	6.3
24-in. Brick wall	.6	1.2	1.8	2.4	3.0	3.6	4.2
8-in. Concrete wall	1.6	3.2	4.8	6.4	8.0	9.6	11.2
12-in. Concrete wall	1.1	2.2	3.3	4.4	5.5	6.6	7.7
24-in. Concrete wall	.7	1.4	2.1	2.8	3.5	4.2	4.9
4-in. Hollow tile, plaster both sides	1.5	3.0	4.5	6.0	7.5	9.0	10.5
8-in. Hollow tile, plaster both sides	1.2	2.4	3.6	4.8	6.0	7.2	8.4
12-in. Hollow tile, plaster both sides	1.0	2.0	3.0	4.0	5.0	6.0	7.0
Frame wall, plaster outside	1.3	2.6	3.9	5.2	6.5	7.8	9.1
Frame wall, double board outside	1.0	2.0	3.0	4.0	5.0	6.0	7.0
Partition, Lath and plaster one side	1.2	2.4	3.6	4.8	6.0	7.2	8.4
Partition, Lath and plaster both sides	2.0	4.0	6.0	8.0	10.0	12.0	14.0
Partition, 1-in. wood	1.8	3.6	5.4	7.2	9.0	10.8	12.6
Partition, 2-in. wood	1.2	2.4	3.6	4.8	6.0	7.2	8.4
Wooden floor, double board	.25	.5	.75	1.0	1.25	1.5	1.75
Concrete floor	.9	1.8	2.7	3.6	4.5	5.4	6.3
Wooden floor on concrete	.4	.8	1.2	1.6	2.0	2.4	2.8
Dirt floor	.6	1.2	1.8	2.4	3.0	3.6	4.2
Plaster ceiling, no floor above	1.0	2.0	3.0	4.0	5.0	6.0	7.0
Plaster ceiling, floor above	.75	1.5	2.25	3.0	3.75	4.5	5.25
Wooden ceiling, composition roof	.9	1.8	2.7	3.6	4.5	5.4	6.3
Watts per cu. ft. of air required to heat air	.054	.108	.162	.216	.27	.324	.378

50 deg. F. The average temperature rise is then 20 deg. F. (70 deg. F—50 deg. F.). If a 5-kw. heater adequate to give a 40 deg. F. temperature rise was installed in a room and the room was heated daily for 8 hours per day 25 days per month, the consumption would be:

$$5 \text{ (Kw.)} \times \frac{20}{40} \text{ (factor)} \times 8 \text{ (hrs.)} \times 25 \text{ (days)} = 500 \text{ kw-hr.}$$

The result, however, obtained in this manner would be high as the mean temperature taken above is the mean for the 24-hr. period and the mean for the heating period would be higher as it is warmer during the heating hours than the average for both day and night. Allowance must also be made for heat derived from the sun, which is of great importance.

It is impossible to make an accurate calculation of the monthly consumption of any particular building due to the variation in construction, temperature and heating requirements, but from a close observation of several installations in the San Francisco Bay section, which have been installed for some time and on which very accurate data have been compiled, it has been found that the following are very fair averages:

In each of the following installations heaters of sufficient capacity to maintain a temperature difference of 30 deg. F. between outside and inside room temperature were installed.

Residences: Consumption per month for six winter months where a uniform temperature was maintained, average 20 to 25 kw-hr. per kw. of heater capacity installed.

Offices: Consumption per month for six winter months heating eight hours per day, 26 days per month, average 50 to 60 kw-hr. per kw. of heater capacity installed.

Schools: Consumption per month for six winter months heating five hours per day, 21 days per month, average 35 to 40 kw-hr. per kw. of heater capacity installed.

TABLE II—Homes

	Los Gatos 6 rooms kw. installed	San Francisco 6 rooms kw. installed	San Francisco 6 rooms kw. installed	San Mateo 7 rooms kw. installed	San Francisco 7 rooms kw. installed	Belvedere 7 rooms kw. installed	San Francisco 8 rooms kw. installed	San Francisco 8 rooms kw. installed	San Francisco 8 rooms kw. installed
Range	7	7	8	8	7	8	12.5	7	7
Water heater	5	5	5	5	5	5	5	5	5
Air heaters	21	18.5	18	26.2	19.2	24	34	28	30
Lights and appliances	2	2	2	2.5	2.5	3	3	2.5	3
	kw-hr. consumed	kw-hr. consumed	kw-hr. consumed	kw-hr. consumed	kw-hr. consumed	kw-hr. consumed	kw-hr. consumed	kw-hr. consumed	kw-hr. consumed
Jan. 1925	1,540	1,860	1,306	2,756	1,640	1,855	2,560	3,946	2,688
Feb. 1925	1,420	1,196	958	2,430	1,290	1,771	1,504	2,502	1,952
Mar. 1924	1,490	930	900	1,681	920	1,517	1,184	1,018	1,920
Apr. 1924	1,000	1,142	1,100	1,769	1,110	864	1,664	1,167	1,664
May 1924	560	847	1,118	1,317	910	872	1,152	892	1,216
June 1924	340	885	563	1,207	910	630	960	936	1,184
July 1924	180	898	187	903	822	600	832	458	736
Aug. 1924	590	735	686	739	420	660	704	77	399
Sept. 1924	500	493	955	951	470	708	768	385	640
Oct. 1924	460	814	730	974	780	449	864	760	800
Nov. 1924	660	858	1,097	1,771	915	779	1,216	1,242	992
Dec. 1924	870	1,038	1,353	1,523	1,205	1,424	1,246	1,716	1,312
Total	9,620	11,696	10,953	18,021	11,392	12,129	14,554	15,099	15,503
Estimated consumption for cooking, water heating and lighting	5,520	5,520	5,520	8,400	5,400	6,000	8,400	8,400	8,400
Air heating only	4,100	6,176	5,433	9,621	5,992	6,129	6,154	6,699	7,103
Average per month	342	515	453	802	499	511	513	558	592

Do not attempt to compare the operating cost of electric heating systems with those of other heating systems by means of the B.t.u. given off by combustion of other fuels, as it is an unfair comparison due to the fact that the efficiency of other systems can only be estimated and are usually compared under ideal conditions which do not prove correct under actual tests over long operating periods, furthermore this efficiency decreases as plants are operated at less than full load. The only proper comparisons are derived from the results of satisfactory installations.

In determining the actual annual cost of any heating system the following must be taken into consideration:

1. Interest on initial investment.
2. Insurance on plant.
3. Depreciation of plant.
4. Labor required to operate plant.
5. Repairs necessary to keep plant operating.
6. Cost of fire proof room and necessary flues.
7. Actual cost of fuel.

The flexibility of electric heating systems which permit of the heating of any particular room without the necessity of operating the entire system, also the ease with which the heat can be regulated, must be given careful consideration.

Some Actual Data on Energy Uses in Existing Installations

Tables II to VI present the kw-hr. consumption of a number of homes, apartments, offices, and banks using electricity exclusively for cooking, water heating, air heating, lighting and appliances.

Insulation: Careful consideration should be given to proper insulation of floors, ceilings and walls of buildings, also to air leakage around windows, doors, etc. Improper insulation and drafty rooms will increase the operating cost of any heating system from 25 to 50 per cent. The cost of properly insulating a building compared to the initial cost is so small that it is usually absorbed by the difference of the heating bills in the first year of operation.

Exposed Glass: It has been found from actual installations which have large glass areas that when such areas are on the sunny side of the building that they aid in the heating of the building rather than add to the operating cost. The radiation losses are however greater on dull days but these losses are more than compensated for when the sun is shining. In figuring buildings of this type be sure to note position of building.

Ventilation: Although it appears to be the general custom to ventilate rooms from the ceiling or by opening windows, it is the most costly and unsatisfactory means of properly ventilating. Hot air being lighter than cold air rises and is carried to the outside atmosphere while foul air is heavier than fresh air and falls to floor level. It is not always a simple matter to ventilate rooms from the floor without mechanical means. The cost however is much less by using the electrical energy to drive an exhaust fan for this purpose than to use hot air to create the draft.

Location of Heaters: Heaters should be placed in such a manner as to cause air currents to move away from windows rather than toward them. Very satisfactory results are obtained by locating heaters below the windows. Wall or bracket type heaters should be placed as close to the floor as possible. Long or large rooms should be provided with two or more heaters located as far apart as convenient. It is obvious that better heat distribution is realized from two heaters than from a single one.

TABLE III—Apartments

	San Francisco 16 rooms kw. installed	San Francisco 42 rooms kw. installed	San Francisco 79 rooms kw. installed
Ranges	4 - 7 kw.=28	15 - 7 kw.=105	33 - 6½ kw.=214.5
Water Heaters	20	10	*
Air Heaters	23	110	137
	kw-hr. consumed	kw-hr. consumed	kw-hr. consumed
Jan.	3,171	15,280	13,440
Feb.	2,945	11,120	10,920
Mar.	2,309	10,160	6,000
Apr.	1,930	10,720	6,240
May	1,585	9,120	5,160
June	1,250	8,320	4,680
July	1,163	8,720	5,400
Aug.	1,187	8,380	1,440
Sept.	1,222	8,000	3,120
Oct.	1,271	7,690	2,760
Nov.	1,671	9,880	7,720
Dec.	1,836	14,590	12,320
Total	21,540	121,980	79,200
Estimated consumption cooking and water heating	8,640	93,000	†31,680
Heating only	12,900	28,980	47,520
Average per month	1,075	2,415	3,960
Average per room per month	67	58	50

*Separate meter. †Cooking only.

TABLE IV—Offices

	San Francisco	San Francisco	San Francisco
Kw. installed for air heating	10.8	20	27
	kw-hr. consumed	kw-hr. consumed	kw-hr. consumed
Jan.	1,542	3,270	3,408
Feb.	843	2,296	2,448
Mar.	668	1,032	792
Apr.	384	1,361	984
May	118	1,039	168
June	6	89	264
July	7	69	48
Aug.	76	198	288
Sept.	18	259	120
Oct.	103	536	24
Nov.	551	1,403	576
Dec.	1,150	1,458	1,968
Total	5,466	13,010	11,088
Average per month	455	1,084	924
Average per kw. connected per month	42	54	34

Humidity: This is a very important factor in the East and Middle West where the temperature is around zero and the percentage of moisture in the air is low. However, on the Pacific Coast during the heating period the percentage of moisture in the outside air is high and as the difference in temperature is not great, the outside air when brought up to room temperature usually contains sufficient percentage of moisture so that it is not necessary to add any.

TABLE V—Banks

	Oakland	Santa Rosa	San Leandro	Sausalito
Kw. installed for air heating	24.4	12.6	31.8	43
	kw-hr. consumed	kw-hr. consumed	kw-hr. consumed	kw-hr. consumed
Jan. 1925	2,558	2,705	2,970	5,000
Feb. 1925	1,672	2,544	2,670	5,300
Mar. 1924	650	1,277	1,350	3,175
Apr. 1924	883	700	.....	.....
May 1924	164	100	.....	.....
June 1924	219	118	.....	.....
July 1924	59	60	.....	.....
Aug. 1924	108	.....	.....	.....
Sept. 1924	62	.....	.....	.....
Oct. 1924	118	39	30	75
Nov. 1924	792	638	600	1,875
Dec. 1924	1,951	1,200	1,230	3,050
Total	9,216	9,381	*8,850	*18,475
Average per month	768	782	†1,475	†3,079

*For six months.
†Per six months.

TABLE VI—Automobile Show Room and Offices

	San Francisco	San Francisco	San Francisco
Kw. installed for air heating	15.8	66.6	177.9
	kw-hr. consumed	kw-hr. consumed	kw-hr. consumed
Jan. 1925	3,289	8,040	*23,040
Feb. 1925	2,550	*9,000	*23,040
Mar. 1924	1,691	4,560	5,760
Apr. 1924	2,394	4,260	6,120
May 1924	1,089	1,440	3,600
June 1924	573	1,200	1,680
July 1924	170	240	†1,800
Aug. 1924	307	360	†2,400
Sept. 1924	287	720	†1,200
Oct. 1924	864	420	†1,920
Nov. 1924	2,035	1,560	†3,360
Dec. 1924	2,723	3,300	†3,960
Total	17,972	35,100	77,880
Average per month	1,496	2,917	6,490

*1924
†1923

Stimulating Interest in Better Farm Lighting

Report of the Cooperative Farm Lighting Committee, Lighting Bureau, Commercial Section*

UPON the completion of its activities in the other lighting fields for the current association year, the Lighting Bureau turned its attention to the rural lighting situation. As a result, the Cooperative Farm Lighting Committee was appointed in September of 1924 for the purpose of stimulating interest among rural consumers in better farm lighting and especially in the better lighting of the rural home. It was further decided at this time that the work of the committee was to be cooperative throughout with the concurrent campaign of similar bodies.

To avoid a duplication of effort, our plans were constructed around the work being carried on in this field by the California Committee on the Relation of Electricity to Agriculture and by the Division of Agricultural Extension of the University of California.

A preliminary survey was made by the committee to ascertain the scope of the field, and, from the data secured, it was very forcibly shown that our efforts must be guided by two major premises.

1. The majority of rural homes are, on an average, very poorly lighted.
2. The utilization of electricity in the lighting of farm yards and buildings is practically negligible.

An investigation was made to determine the reason for the existence of these conditions. From the majority of cases it was found that the main reason lay in the fact that rural consumers, as a class, have not been educated either to the means of obtaining adequate light or to the hygienic methods of controlling it.

The existence of this condition is not the fault of the rural consumer, but is, rather, the fault of the industry. This agency which could have eliminated the problem at its source has consistently neglected farm lighting, probably because it was, at the same time, magnifying farm power beyond the point of its relative importance.

In order to extend its effectiveness in coping with the existing erroneous custom, the committee desired to stimulate interest directly among the rural consumers themselves through the medium of comprehensive lighting demonstrations, to be carried on in cooperation with the central stations.

After very carefully considering all the ways by which the demonstration could be most effectively made, we agreed that the farm lighting exhibit given by the Division of Agricultural Extension of the University of California was the best vehicle for the work.

An attempt was made to join with the University of California in a purely non-commercial manner toward the furtherance of the university's splendid work. However, on account of certain unalterable university rules, the authorities could not accept our offer of cooperation. The Extension Division appreciates the interest we have taken in its rural lighting activities and desires that our association be apprised of its regret that our activities cannot be carried on jointly.

The committee, therefore, must now devise a means of its own for carrying a proper understanding of lighting principles and practice to our rural consumers. We are firm in our belief that a portable exhibit that may be transported throughout the rural territory is the most effective medium for accomplishing this end. The field is so large that a duplication of effort is hardly probable. For the committee's purpose the University of California exhibit could be duplicated, or modified to fit local conditions, and, with a firm basis of cooperation between the association and the central stations, the message of better farm lighting can be spread throughout the rural districts to the mutual advantage of all concerned.

This matter is now receiving the attention of the committee and a supplemental report will be filed as soon as due consideration has been given to the subject.

*N. R. Sutherland, Pacific Gas and Electric Company, chairman; H. E. Cook, Edison Lamp Works; W. C. McWhinney, Southern California Edison Company; L. J. Nevraumont, Pacific Gas and Electric Company.

Teaching the Fundamentals of Better Lighting

Report of the Lighting Schools Subcommittee, Lighting Bureau, Commercial Section.*

A report covering the activities of this committee, which consisted mainly of the conducting of two lighting schools, one in Los Angeles and the other in Oakland, was presented in the April 15, 1925 issue of the Journal of Electricity, p. 284. Complete information concerning the methods of conducting these schools was presented in the article, and it is not considered necessary to repeat the report here.

It is sufficient to state that the two schools drew an attendance of 103 men vitally interested in better illumination and that the organization of a permanent lighting school has been suggested to the committee. The schools were designed to give information of an elementary nature and the suggestion has been made that secondary schools be conducted to supplement the work of the first schools.

*Clark Baker, National Lamp Works, chairman; H. H. Allison, Electric Appliance Company, vice-chairman.

Following Up the National Better Home Lighting Contest

Report of the Home Lighting Follow-Up Subcommittee, Lighting Bureau, Commercial Section*

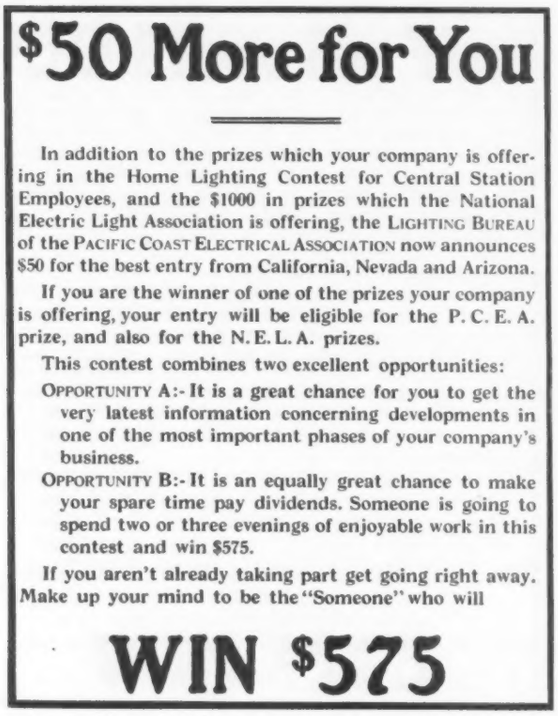
IN order that some definite picture may be had of the basis upon which it was planned that this committee might work, the final results in Region 12 of the Better Home Lighting Contest are presented.

Number of towns participating	243
Number of eligible school children	232,676
Number of Primers actually distributed	67,696
Number of signed registration cards received	26,769
Number of final entries submitted	4,646

NOTE: From these figures it will be observed that 29 per cent of the eligible school children of this region actually received primers and commenced work in the contest; and that 7 per cent of the primers distributed were returned completed to the committee. Tnis figure does not represent the entire number of entrants who carried their work through to completion, as in many cases where the work was conducted as part of the school course the teachers graded the entries themselves and only turned over the best to the committee.

Two meetings of the Better Home Lighting Contest Committee of the Pacific Coast Electrical Association have been held. One in Los Angeles on Oct. 17, 1924, the other in San Rafael, on Nov. 19, 1924, the latter being a joint meeting with the Lighting Bureau of the National Electric Light Association.

Recognizing that the follow-up of such a strictly non-commercial activity as was the Better Home Lighting Contest rested largely in the hands of individual companies, and that there were very severe instructions upon the possible follow-up by such a neutral organization as the Pacific Coast Electrical Association, the personnel of this committee was extended to twelve members in order that the committee meetings might serve as a forum for the interchange of ideas which the individual companies represented might put into practice.


$50 More for You
In addition to the prizes which your company is offering in the Home Lighting Contest for Central Station Employees, and the $1000 in prizes which the National Electric Light Association is offering, the LIGHTING BUREAU of the PACIFIC COAST ELECTRICAL ASSOCIATION now announces $50 for the best entry from California, Nevada and Arizona.
If you are the winner of one of the prizes your company is offering, your entry will be eligible for the P. C. E. A. prize, and also for the N. E. L. A. prizes.
This contest combines two excellent opportunities:
OPPORTUNITY A:- It is a great chance for you to get the very latest information concerning developments in one of the most important phases of your company's business.
OPPORTUNITY B:- It is an equally great chance to make your spare time pay dividends. Someone is going to spend two or three evenings of enjoyable work in this contest and win $575.
If you aren't already taking part get going right away. Make up your mind to be the "Someone" who will
WIN $575

Poster used by the Lighting Bureau to announce the P.C.E.A. prize for the Power Companies' Employees Home Lighting Contest

The committee has been advised that the Primers submitted by thirty-four school children in Region 12 were of such excellence as to warrant the awarding of special mention in addition to the regular list of prizes offered by the National Better Home Lighting Committee. Bronze medals have been made for these children and will be sent to them in the near future. This committee will endeavor to secure as much publicity as is possible in connection with the awarding of these medals, through the local newspapers of the districts in which the winners reside.

The most important activity of the committee as a body has been the fostering in California of the Power Companies' Employees Home Lighting Contest which involves the study of the same Primer as was used in the school children's contest, and practically the same effort on the part of the power company employees who participated in the contest.

Six California companies have definitely signified their intention of participating in this contest, and ordered 7,000 Primers for distribution among their employees. In order to stimulate additional interest and enthusiasm, the Lighting Bureau of the Pacific Coast Electrical Association has offered a prize of $50 and has issued and distributed among the participating power companies, posters calling attention to the contest and to the various prizes which it is possible for an entrant to win.

The committee has also communicated with all power companies in California urging them to undertake a kitchen lighting campaign before the interest which the school children's contest aroused has subsided. Three power companies already have such sales effort under way, while two others have their plans about perfected.

Another activity which the committee has discussed but for which the final plans have not been worked out in detail, as yet, is that of overcoming the use of wrong voltage lamps, and the consequent loss to all parties concerned, consumer as well as electrical interests.

Another meeting of this committee will be held on April 3, at which time it is hoped that definite plans may be concluded for those activities which this committee has undertaken, but which are not yet under way.

It is too early at the time of writing this report to make a full report on the results of the Better Home Lighting Contest among power company employees. The contest will close on April 15, and this report is being submitted as of April 3.

A great many contestants have been enrolled and it is confidently expected, among the power companies participating, that a great deal of benefit will be derived by those employees who have joined in this work, and that the industry will benefit by the added knowledge.

A copy of the poster offering a prize of $50 for the winner of the Pacific Coast Electrical Association prize, and which was sent to all power companies, is attached to this report.

* V. W. Hartley, California Electrical Bureau, chairman; F. J. Airey, Pacific States Electric Company; Clark Baker, National Lamp Works; C. W. Cole, C. W. Cole & Company; J. R. Cravath, Pioneer Electric Company; G. H. P. Dellman, San Diego Consolidated Gas & Electric Company; M. C. Hixon, Edison Lamp Works; L. A. Hobbs, Edwin F. Booth Company; C. M. Masson, Southern California Edison Company; D. C. Pence, Illinois Electric Company; R. S. Prussia, Westinghouse Lamp Company; J. S. G. Ross, Pacific Gas and Electric Company; H. E. Sherman, Jr., Great Western Power Company.

Electricity and the California Dairy Farm

Report of the Subcommittee on Electric Power on the Dairy Farm.*

SO much publicity has been given the subject of electricity in agriculture that it is scarcely necessary at this time to go into the many problems yet to be solved in order to bring about more extensive use of electricity on the farm. It would seem more advisable to elaborate upon cases in some fields where the major problem "Electricity on the Farm" has actually been solved, and point out certain features in this field which could yet be developed with resulting increased business for the manufacturer, greater kw-hr. sales by the central station, and reduced costs of operation with greater production for the farmer himself.

No other state offers a better opportunity for such a study than does California, where the use of electricity

*Subcommittee on Electric Power on the Dairy Farm, Power Bureau, Commercial Section—J. E. Barrett, San Joaquin Light & Power Corporation, chairman; E. G. Stahl, San Joaquin Light & Power Corporation; P. S. George, Coast Valleys Gas & Electric Company.

for pump irrigation alone results in an annual use of from 300 to 600 kw-hr. per acre, and no type of farm is more attractive for a field of endeavor along such lines than the California dairy farm.

Essentially An Industry

A dairy farm may be looked upon as being essentially an industry, inasmuch as the raw product (products of the soil) are converted into products (milk, butterfat, etc.) ready for the market. The use of power on the dairy farm has the same characteristics as other industrial loads namely, relatively high load factors resulting from diversified use of power.

It seems that the work of promoting the use of more electricity on the dairy farm should first be backed by the central station, in that it results in a greater use of electricity with improving load factor conditions. Second, the manufacturer of dairy farm machinery should assist, inasmuch as this development offers him a large field of prospects for the sale of machinery. Third, the farmer himself should see the value of the movement, for in many cases it will be found that by using methods which require electricity he will be able to not only increase production, but also to reduce the cost of production.

California Dairy Farms

From the best information available, we find that there are approximately thirty thousand dairy farms in California, not taking into consideration any farms supporting less than twenty-six head. While electrification has progressed to a very large extent, it is safe to say that practically none of these farms are completely electrified; that is to say, there are none of these thirty thousand farms upon which more energy could not be advantageously used. This statement emphasizes the extent to which more equipment can be sold and more energy delivered before the saturation point will become a factor.

While no accurate figures are available as to what portion of the dairy farms in the state are users of electricity, or as to what extent it is used by those dairy farms which have the service available, a general knowledge of conditions gives a basis for certain assumptions which are used hereafter as a basis for showing the value of the dairy farm to those interested in the electrical industry.

The field may be divided into two groups; the first group being representative of all those dairy farms in the state which use electric energy for one purpose or another, and the second group representing those dairy farms which use no electric power whatever. The first group represents immediate prospects for the sale of additional equipment and kw-hr. The second group, although representing prospects, is of a different type, where economic laws must be given first consideration before any of the farms become potential prospects.

Tables I, II, and III show the value of dairy farms to the industry, considering value of equipment now used; value of equipment which it would be possible to add where service already exists; and value of equipment as applied to those farms now without service.

Table I—Dairy Farm Equipment
(Electrical equipment now in use)

	Number	Value	Kw-hr. Used Per Year
Pumps	16,000	$16,000,000	240,000,000
Cream separators	10,000	1,200,000	2,400,000
Milking machines	3,000	3,000,000	6,000,000
Sterilizers	500	100,000	1,600,000
Utility motors	500	100,000	700,000
Domestic service	13,000	3,250,000	2,600,000
		$23,650,000	253,300,000

The next step would seem to be the determining of a way in which the total electrification of the dairy farm may be accomplished and in order to discuss this, the various factors to be contended with must be given consideration. Let us, therefore, take up the different types of equipment under their respective heads.

Pumping Plants

The foregoing table shows 14,000 dairy farms in the state which do not pump with electricity. Of these farms there are probably many which either depend on natural rainfall or upon canal water for irrigation. Two thousand of the 14,000 already have service available for other uses and it is reasonable to assume that at least 1,000 of these will eventually go to electric pumping. Of the other 12,000, many also depend upon natural rainfall and canal water for irrigation and we may assume that half of these will eventually pump by electricity. However, some of them are located so far from existing lines that the economic factor would completely eliminate them as present prospects, but it is believed that if we reduce the original 12,000 by about 70 per cent, we will arrive at a figure which is fairly conservative. This then reduces itself to the statement that there are yet 1,000 pumping plants to be installed on dairy farms already using electric service, and 2,400 pumping plants on dairy farms where no service is available, making a total of 3,400 pumping plants in prospect.

Table II—Electrical equipment which could be added where farms have service available

	Number	Value	Kw-hr. Used Per Year
Pumps	2,000	$ 2,000,000	30,000,000
Cream separators	8,000	960,000	1,300,000
Milking machines	15,000	15,000,000	30,000,000
Sterilizers	17,500	3,500,000	52,000,000
Utility motors	17,500	3,500,000	26,000,000
Domestic service	5,000	750,000	1,000,000
		$25,710,000	140,300,000

Table III—Electrical equipment to be sold where no service is now used

	Number	Approximate Value	Possible Kw-hr. Used Per Year
Pumps	12,000	$12,000,000	180,000,000
Cream separators	12,000	1,440,000	2,900,000
Milking machines	12,000	12,000,000	24,000,000
Sterilizers	12,000	2,400,000	14,400,000
Utility motors	12,000	2,400,000	16,800,000
Domestic service	12,000	3,000,000	2,400,000
		$33,240,000	240,500,000

Cream Separators

The first factor which confronts us here is that many dairymen do not separate their cream, selling their product in the form of raw milk to dairy companies in cities, etc. This, in itself, will have a direct influence upon our assumptions. The previous table indicates that 8,000 dairy ranches do not separate cream by electric power, although they use power for other purposes; and that 12,000 dairy farms which have no electric power could use electric separators if power were available. On the surface, this would seem to indicate the possible installation of 20,000 cream separators, but due to the raw milk factor, of which we have no accurate information, we should reduce our figures at least 50 per cent. Then comes the economic factor dealing with distance from existing lines, which will still further reduce the figure for these farms which have no service available. In view of the fact that revenue is small for this equipment, and as a consequence no great amount of line can be built to serve it, this latter factor should be high. Let us assume that the 12,000, after being reduced 50 per cent on account of the raw milk factor, be still further reduced by a factor of about 80 per cent.

This leaves 4,000 electric separator installations where service is already available, and 1,200 where service is not now installed, or a total of 5,200 in prospect. Many of these machines are operated on the same meter as are residence lights, and for this reason, the cost of operation is a matter of guesswork, although the cost in many cases would not exceed $2.00 per month.

Milking Machines

Since milking must be done one way or another, it should be conceded that every dairy farm having service available can, by the application of the proper sales effort, be induced to install electrical milking machines. This development would result in the sale of 15,000 machines on farms now having service. If we are able to serve the 2,400 pumping plants on dairy farms not now having service available, the same sales effort would be able to get these same ranches to use electric milking machines. We, therefore, can assume the field will absorb 17,400 milking machines.

There are factors which might tend to reduce this number, but with proper sales effort these may be overcome. Many dairymen are of foreign extraction and have looked with suspicion upon mechanical milking. Some claim that cows go dry too soon when milked

by machine and others do not like them for the reason that they require cleaning and sterilizing after each milking; whereas, with hand milking this factor is not necessary. However, if a thorough study is made of the savings in labor which may be obtained by machine milking, these objections may be overcome. Many dairymen pay from $90 to $100 per month for good milkers, and are confronted with a labor problem when these men are asked to do other work. They take the attitude that they are paid for milking only and refuse to do anything else. In such cases the cost of labor runs from $1,200 to $2,400 per year, depending upon the number of cows milked. One definite case is known where one man and a milking machine are milking, twice daily, 65 cows. These cows yield about 64,000 gal. of milk per year; the machine consuming 2,250 kw-hr. per year at a cost of energy of $90. The machine itself cost $1,000 installed, and if we allow generous depreciation and interest on the investment, the cost of operating the machine would not exceed $300 per year, and it actually has replaced a man whose labor was costing $900 per year more than the operation of the machine. If this much could be saved for each of the 17,400 dairymen previously mentioned, the savings per year of labor cost would exceed 15½ millions of dollars.

Sterilizers

This type of electrical equipment is comparatively new to the dairyman. Practically every dairy farm has sterilization equipment, using oil, wood, or coal as fuel, but not until recently has there been much of an effort made to develop a unit operated by electricity. The most familiar type consists of a heat insulated tank, of convenient size, in which is installed a 5-kw. heating element. This apparatus gives sufficient steam pressure to allow thorough sterilization, at the same time supplying scalding water for washing cans, etc. One case is known where sterilization of cans, etc. for a herd of thirty cows costs but $3.60 per month; others show costs from $4 to $5 per month, depending upon the amount of milking done.

It should be possible with proper effort to have installed 17,500 of these on dairy farms now using service and one for each farm not now using service when it is possible to close with them for electric pumping. This would result in the ultimate installation of 19,900 sterilizers.

Utility Motors

Here is another use for power and equipment which has been passed up heretofore as very remote, due to the inconvenience in moving the equipment, which, in most cases, has been considered as including transformers, line, etc. Modern practice has proved that the farm yard can be so arranged that very little moving of equipment is necessary, this being accomplished by means of a portable motor with a flexible cable attached so that it can be conveniently moved from one location to another about a central point near the transformer pole.

The uses of the equipment are many, consisting of feed grinding, hay hoisting, wood cutting, operation of miscellaneous farm yard machinery, etc. The value of the equipment to the dairyman is more or less indeterminable, but it is known that much more chopped hay may be stored in a given space than would be possible with whole hay, which tends to economize in space. Then, too, the value of feeding chopped hay should also prove advantageous. It is claimed by the University of California Experimental Farm at Fresno that about 300 lb. of hay out of every ton is saved by chopping, this resulting by the cattle eating more or less of the stalks which are wasted to a large extent in feeding whole hay.

From the same source comes the information that 30 per cent more milk can be obtained per ton of hay in feeding chopped hay as compared to loose hay. If the output of an average dairy farm can be increased 30 per cent, the increase would be approximately 10,000 gal. per year, which, at 20 cents per gal., amounts to $2,500 additional return per dairy farm.

The idea of using this equipment must be sold by educational methods. In most cases the dairyman will have to be shown the value of feeding chopped hay before he can be considered a prospect.

It is estimated that only 500 dairy farms in the state are at the present time using utility motors, leaving a field of 17,500 in which to work up this business. It would be possible to utilize the pumping plant motor for this purpose, but not necessarily practical. It is felt that at least 15,000 motors for this use could be sold on diary farms now having service if it were possible to promote the idea of feeding chopped hay, ground feed, etc., and about 2,000 on farms where it would be possible to extend lines to serve pumping plants. Therefore, 17,000 of these motors could ultimately be absorbed by the dairy farms of the state.

Domestic Service

The previous table shows 5,000 farms having electric service available but not using it for domestic purposes and we should add to this number the homes on farms not now having service, but which are considered electric pump prospects. This would make 7,400 farm homes prospects for domestic service. Here, in many cases, intensive sales work will be necessary to induce the installation of appliances. Educational work is recommended, dealing with lighting of homes, also with regard to the many conveniences now on the market. The work of adding appliances in homes already using service is not to be considered at this time. We merely assume that each home added to the lines of the central station will be an average as to the number of outlets, number of appliances, etc.

Summary

Summarizing can be done to a better advantage by means of Table IV, which shows the value of the California dairy farm to the electrical industry, and which is a net result after taking into consideration the various factors to be contended with. This table shows the possibility of the sale of $30,654,000 worth of dairy farm equipment and household appliances, with the resultant sale of 176,010,000 kw-hr. per year.

Table IV—Total value of farms to electrical industry

	Number	Value	Kw-hr. Used Per Year
Pumps	3,400	$ 3,400,000	51,000,000
Cream separators	5,200	624,000	1,250,000
Milking machines	17,400	17,400,000	34,800,000
Sterilizers	19,900	3,980,000	63,680,000
Utility motors	17,000	3,400,000	23,800,000
Domestic service	7,400	1,850,000	1,480,000
		$30,654,000	176,010,000

This means that the California dairy farm is a prospect for over $30,000,000 worth of equipment. On referring to two particular types of equipment namely, milking machines and utility motors, it is noteworthy that the saving to be effected and increased return to be realized by the dairy farm represents a figure far in excess of the value of all equipment still to be installed.

The answer, then, would be first to attempt to put as much of this equipment into operation as possible, and then follow up each installation as a live prospect for additional equipment, to be paid for out of the resulting savings and increased return which is brought about. Comprehensive surveys should be made which would give the central station more definite information regarding this type of load, and close cooperation between central station and farmers' organizations must be maintained in order to accomplish the proper education along these lines.

Testing Service for Agricultural Pumping Plants

Report of the Subcommittee on Pump Testing Service, Agricultural Power Committee, Power Bureau, Commercial Section*

RURAL electrification in California has reached a point of greater development than in any other state in the Union. This comparatively advanced development is directly traceable to the fact that a vast amount of California irrigable land is served with pumped water. Electricity has proved to be the most economical power for operating pumps, and conse-

* E. G. Stahl, San Joaquin Light & Power Corporation, chairman; W. L. Boxall, Southern California Edison Company; W. C. North, General Electric Company; R. A. Balzari, Westinghouse Electric & Manufacturing Company; B. D. Moses, University Farm.

quently the use of electrically powered pumps has become general throughout the agricultural section of the state. As a result, we have derived from our agricultural consumers sufficient revenue to warrant an investment for line construction which otherwise would not be justified. The result has been that the California farmer has available electric power for domestic, utility, and all other services. This has brought to him comforts and conveniences, ordinarily only available in larger centers of population.

Successful farming can no longer be conducted by haphazard methods. It has become a systematized business, with cost accounting records comparable with other business endeavors. While electric pumping costs are a small percentage of the total operating expenses of the farmer, the fact that these costs must be paid monthly, and the fact that most of his revenue is derived from annual crops, brings them constantly to the farmer's attention. Poor pump performance, and consequently low efficiency, of course, have a direct bearing on the power consumption, with a resultant increase in power bills.

Because the farmer has come to regard cost of operation as an item of importance, any increases in power bills immediately come to his attention, and he is most interested to determine the cause. For this reason it is thought advisable that the power companies lend such assistance as they can to help the farmer determine and correct the causes of poor pump performance.

The fact that this agricultural pumping load has not only made rural electrification possible, but also general, in California, would seem to indicate that it is, perhaps, the backbone of rural extension possibilities, and therefore warrants considerably more service and attention than many other classifications of business.

Those power companies who have already established a testing service for agricultural pumping plants have rendered a direct service to the farmer in having assisted him in establishing his operations on the most economical basis. The information that has been gathered in connection with the work has also made it possible to disseminate ideas on better irrigation methods, as well as directly increase the use of electric power for pumping.

This service, which is given without charge to the farmer, has also proved valuable in creating friendly relations, and has been a valuable asset to selling efforts in rural territories.

Equipment and Method of Testing

The over-all efficiency of the pump is calculated from the discharge, the power input and the measured lift. Where weirs, concrete reservoirs or tanks are installed at the plant, the discharge can be obtained easily enough. However, many plants discharge directly into pipe lines, and in such cases the General Electric flow meter is used. To connect the meter to the discharge pipe, a ¾-in. hole is drilled and tapped. A perforated brass tube is then inserted across the flow of water, the inside diameter of the pipe having been carefully measured. The meter itself consists of a glass U tube filled with mercury, the flow of the water exerting pressure on the tube of mercury causing it to rise or fall. The tube is calibrated so that readings can be made easily from the position of the mercury under the water pressure. Careful checks have shown this method to be very accurate.

The power input is ordinarily obtained by timing the revolutions of the disk of the meter.

Determining Lift

The lift is determined in several ways, depending upon the character of the installation. As pump manufacturers usually specify the size of suction and discharge pipes to the surface of the ground, it is not customary to make allowance for friction from the water level to this point.

When water is discharged at a higher level, a calibrated pressure gage is used at the surface and the measured lift from the water level to the gage is added to determine the total lift unless otherwise specified in the manufacturer's guarantee.

When deep well turbines are installed in well casings, a small electric sounder is lowered to the water level by means of a steel tape. As the surface of the water in this casing is often covered with several inches of oil from the lubricating system, the sounder must be operative after its point has passed through the oil. When the sounder is withdrawn, the tape is measured to determine the lift.

In some cases the pumping level is determined by air pressure. A measured length of ½-in. pipe is lowered at the time the turbine is installed. The pipe is lowered to allow several feet of water to stand in the lower end. The top is fitted with a pressure gage below which is placed a valve. Air is pumped through this valve until the gage reads a maximum value, which reading determines the water level. The gage is read before starting the pump and again after it has been operating for a short time. These readings give the draw-down due to pumping.

Given the flow, the power, and the lift, it is a relatively simple matter to determine the efficiency of a pumping plant.

In order to make more definite comparisons of the efficiency of the pumps alone, the over-all efficiency is divided by the efficiency of the motor and the estimated efficiency of transmission where pumps are not directly connected to motors.

The complete cost of the pump testing equipment should not exceed $850. This equipment can be mounted in a case and be transported on a light car.

The expense of conducting tests varies with the distance traveled, location and arrangement of pumping equipment. A minimum cost would be about $5 per test.

A selection of the proper type of man for operator is essential. He should have sufficient technical knowledge and mechanical ability to conduct the test accurately, as well as enough tact and diplomacy to take advantage of the contact thus made.

Selection of Pumping Plant Equipment

The three-phase induction motor is almost universally used for well pumping. In sizes up to 35 hp., 220-volt motors are practical. Above 35 hp., 440-volt motors are generally used. The full load efficiency of standard three-phase induction motors is fairly constant—ranging from 85 per cent at 5 hp., to 91 per cent at 100 hp.

Centrifugal pumps, on account of lower first cost, are advisable for low head pump service where the seasonal draw-down is not excessive, and where the water plane will not be lowered by future installations. The best results are secured when the suction lift is not more than 20 ft., and as under most conditions the maximum depth of the pit should not exceed 20 ft., we may say, as a general rule, that the centrifugal pump is adaptable to heads totaling 40 ft.

Turbine pumps are used for higher heads, and, in some localities, for low heads where there is an excessive seasonal fluctuation and a probability of a future lowering of the water plane to a point where centrifugal pumps would not be practicable.

There is very little difference in the efficiency of either type of pump when properly installed, and the choice should be determined by first cost and water conditions.

The size of pump should be determined by the "water make" of the well and the flow of water necessary for the irrigation desired. The pump capacity should not be so great as to cause an excessive draw-down, as this may result in uneconomical operation and a short-lived well.

Where the quantity of water desired is less than the well can develop, the size of pump should be governed by the irrigation needs. Generally it is cheaper to use the smallest plant that will adequately water the area in question. There is a balance limit, however. The plant should not be so small that it will increase irrigation labor costs more than the probable power saving. A general knowledge of all conditions affecting size and type of equipment for a given installation is usually available through tests that have been run on adjacent plants. If this information is not available, a test may be run on the developing pump at the new well from which the proper choice of equipment can be determined.

Often the pump equipment is purchased on a guaranteed performance basis. An accurate test after the installation is made assists the pump manufacturer in living up to specifications and assures the farmer of getting what he pays for.

Efficiency of Irrigation Pumping Plants

The efficiency of irrigation pumps when correctly installed, should range from 58 per cent to 70 per cent and the over-all efficiency of pump and motor should be at least 50 per cent and sometimes runs as high as 64 per cent.

The cause of poor performance seldom lies in the power service, but nevertheless the power company is oftentimes held responsible for high operating costs. In these instances a test on the pumping plant will at least definitely establish the cause of poor performance, and many times a correction can be made at a nominal expense with a great saving in the cost of water.

It might be of interest to cite an example of the importance of good pump efficiency, which was brought to light through the testing service. A certain rancher operating ten 50-hp. pumping plants, on the west side of the San Joaquin Valley, happened to have two of these plants located just one-half mile apart. Apparently, the water conditions of the two wells were exactly the same and the same type of pump and motor was installed at each well. The power input to the motors was approximately the same. One well delivered 1,200 gal. per min. and the other only 422.

Table I—Copy of report which is submitted to consumer, showing results from test on pump plant.

CRAWFORD-NOBLETT PLANT—CARUTHERS
Equipment

Meter—Westinghouse—5 amp.—220-volt—No. 31969 in series with potential and current transformers, ratio 20 to 5.

Motor—Fairbanks Morse—15 hp.—220 volts—1,140 r.p.m.—Serial No. 72586 direct connected to

Pump—Fresno Agricultural, 6-in.

Test Results

	First Test	Second Test
R.p.m. of motor and pump	1,080	1,148
Pumping level from center of pump	24 ft. 6½ in.	24 ft. 9 in.
Lift above center of pump	17 ft. 5½ in.	15 ft. 6 in.
Total head	42 ft.	40 ft. 3 in.
Gallons per minute pumped	420	904
Miners inches pumped	46.7	100.5
Acre-feet pumped in 24 hours	1.9	3.99
Kilowatt input to motor	9.02	12.54
Horsepower input to motor	12.1	16.81
Kw-hr. per miners in. in 24 hrs.	4.6	2.99
Kw-hr. per acre-feet pumped	115.6	75.07
Aver. cost per kw-hr. over period of 1 yr.	$0.02	$0.02
Average cost per acre-foot	$3.812	$1.5014
Overall efficiency	36.9%	54.5%
Pump efficiency	43.0%	64.2%
Percent full load to motor	71.0%	98.3%

After the first test was made, a report was submitted with recommendations for changes necessary to improve efficiency of operation. The second test shows results secured after changes were made.

A test on these two plants determined the fact that the turbine bowls on the plant delivering the lesser quantity of water, were set considerably above the pumping level. The fact that it was necessary for this pump to work under what was practically suction limit, would not permit of more than a 40 per cent capacity load. Under these conditions, the cost per acre-foot of water delivered, from the 422 gal. per min. well, was $7.56, as compared with $2.37 per acre-foot from the 1,200-gal. per min. well. A knowledge of these facts persuaded the farmer in question to recondition and lower the pump which was delivering only 422 gal. per min. The cost of these repairs amounted to only a small proportion of the loss he had been sustaining for the past year.

A second test on the two wells, after the change had been made, showed that both wells were producing water at approximately $2.37 per acre-ft. In this instance, the possible saving was much greater than is found in the average case. However, the example illustrates the possibilities of the service. A typical report on a test is shown in Table I.

Causes of Poor Pump Performance

An analysis of the tests made over a period of three years indicates that there are three principal causes for improper operation: first, changes in conditions after the pump has been installed; second, pump wear; third, the proper pump to fit the conditions as they exist is not always the one selected.

It appears that the power company is the logical medium for carrying on this testing service. In the first place, there are several benefits to the power company itself to be obtained through this work. It is an excellent aid in eliminating complaints; it is of considerable help in sales endeavor; it gives a good contact with all classes of farmers, and helps sell the idea that the industry is interested in their well-being.

The benefits to the consumer are numerous. It offers a protection against unscrupulous agents. It is a means of accurately determining performance, and consequently permits the farmer to buy on a guaranteed basis. It serves as a guide to determine when repairs and reconditions should be made. It helps determine the cause of poor performance and what should be done to correct it. It makes possible a correct knowledge of water costs and application. From the application data, information on water duty for different type soils is made available.

From the results of the tests already conducted, the power company has an accurate record of water conditions in various parts of the territory it serves. From this data, it has been possible for salesmen to sufficiently inform themselves on water duty, so that they can quote cost figures on crop irrigation as well as make a reasonable estimate of pumping plant requirements. This information is of material assistance, both to the farmer and the power company.

With the definite information made available by these tests, it becomes much less difficult to spread the fact that electricity is the most economical power for pumping.

Generated vs. Purchased Power in Various Industries

Report of the Competitive Power Committee, Power Bureau, Commercial Section*

FIVE important phases of the question of using central station energy as against energy generated in isolated plants were considered by this committee during the year. This work was assigned to various subcommittees as follows:

Waste Heat Utilization in Cement Plants for Power Generation vs. Purchased Power.....W. F. Neiman
Generated vs. Purchased Power in Laundries.....J. C. Kyle
Generated vs. Purchased Power in Sawmills.....H. N. Carroll
Generated vs. Purchased Power in Large Hotels.....G. A. Peers
Large Diesel Engine Installations.....W. F. Neiman

Reports were prepared covering the first, third and fourth subjects and a temporary report on the second subject, with the promise of a more complete report at a later date. No report has been made on the fifth subject. Limited copies of these complete reports will be made available for those members of the association desiring them. The following summaries of each re port give an idea of their scope.

Waste Heat Utilization in Cement Plants

Waste heat utilization for power generation in cement plants is a proven engineering possibility, but its economic practicability depends not only on the amount of heat that may be recovered from the kiln gases and the relative amount of power that may be produced from the steam generated by the passing of these gases through waste heat boilers as compared with the amount of power required in the production of cement from the material available, but also on the full cost of the power thus generated (and the cost of any additional power necessary) as compared with the cost of the total power required, if otherwise produced or purchased. Another factor entering into the economic side of this question is the supply of limestone. If this, or the market, is limited a cheap plant is desirable and therefore the extra and large investment in waste heat apparatus would not be warranted.

The cost of a waste heat plant if constructed in connection with a new cement mill is estimated at 25 cents per barrel of annual production (present day prices) and the cost of converting an old mill is estimated at double that amount, both by an independent engineer. The cost, however, depends largely on conditions and varies over a considerable range in the conversion of

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established cement mills. The only reliable information received concerning actual costs of waste heat plants was from a 7,000 bbl. per day plant located in Iowa. This was an old mill converted to waste heat power production in March, 1921, and the average cost per barrel of annual production (365 x 7,000) was a little over 52 cents.

The temperature of the gases leaving the kiln is approximately 1,500 deg. F. and after passing through the boiler about 350 deg. F. One plant reports the temperature of the kiln gases as 1,550 deg. F., the temperature on entering the boiler as 1,225 deg. F., on leaving the boiler 480 deg. F., and on leaving the economizer as 360 deg. F., and state that their average evaporation for a period of a year was 425 lb. of water per barrel of clinker produced—this boiler plant is designed to operate at 200 lb. pressure with 100 deg. F. superheat.

The amount of coal burned in the kilns per barrel of cement produced is approximately 100 lb., and the utilization of the waste heat therefrom in a properly constructed plant should yield on the average 350 lb. of steam at 200 lb. pressure and 100 deg. F. superheat. With a turbine using 17½ lb. of steam per kw-hr. delivered at the switchboard, 20 kw-hr. would then be available for each 100 lb. of coal burned. The amount of power consumed per barrel of cement produced varies from 13 to 24 kw-hr. according to data gathered from a number of plants from various parts of the country, and depends on the relative hardness of the cement making material and the fineness to which it and the finished product is ground. The amount of power used in California in cement plants appears to be around 15 to 17 kw-hr. per barrel produced.

From the above it can be seen why some plants can produce all their power requirements, and even an excess, from the kiln gases while others have to burn auxiliary fuel or purchase additional power to make up the deficiency. As all cement plants shut down annually for overhauling, those having waste heat power plants have to burn auxiliary fuel during such period or purchase such power as they may require during that time, and the burning of auxiliary fuel or the purchase of auxiliary power materially reduces the benefits derived from waste heat utilization, and may even absorb them completely. For this reason each waste heat plant is a problem in itself and can only be solved correctly and economically by careful consideration of all the factors entering into the production of cement as well as power, and in the latter the full cost including fixed charges must be reckoned with.

From data received in the course of the investigation on waste heat utilization for power production in cement plants, the cost of power exclusive of fixed charges varies from 3½ to 7½ mills per kw-hr. where sufficient steam is produced to generate all their power requirements while the cement mill is in operation. Where this is not the case the cost (exclusive of fixed charges) may even exceed one cent per kw-hr. The mark strived for in the best plants seems to be one-half cent per kw-hr., however, this is seldom attained. The fixed charges under favorable construction costs vary from 2½ to 3 mills per kw-hr. and the full cost in the best plants is approximately ¾ cent per kw-hr., the others ranging upward.

One plant in Iowa from which full and complete costs of operation, maintenance, repairs and investment were obtained operated at a cost including fixed charges of 7.57 mills per kw-hr. This was a 7,000-bbl. a day plant, maximum demand 6,000 kw., and operated at a load factor of 81.8 per cent. The cost of the same amount of power if purchased on the lines of the Pacific Gas and Electric Company would have been an average of 7.52 mills per kw-hr., or a saving of $176.63 per month, not considering the intangible cost incident to all private plant operation, nor the fact that this investment in the business itself would earn more than the 6 per cent figured as a charge against the plant.

From the investigation then it would appear that at least in California power can be purchased at a less cost than it can be produced by the utilization of the waste heat from the kiln gases in the manufacture of cement, and this probably accounts for the fact that there are no such plants in this state. In the East where power rates are higher, the opinion among cement maufacturers seems to be evenly divided as to whether or not waste heat power production is cheaper than purchased power, but from the data at hand it seems quite likely that some of these concerns would have saved money, in addition to having the capital outlay available for more productive purposes, had they purchased their power instead of investing in waste heat power producing apparatus.

To those interested in information more in detail, copies of the report covering the investigation of this subject will be available.

Generated vs. Purchased Power in Laundries

The subcommittee having this subject under investigation have been gathering data on 32 laundries, 22 of which operate with purchased power. Laundries as a rule express their power costs in percent of gross business done and usually include under this item fuel for the production of steam (and for power where it is generated) labor of engineer, lubricating oil waste, etc., cost of power where purchased, and sometime, though rarely, interest, depreciation and taxes on steam and power producing equipment. While this method gives a general line on the combined cost of steam and power, especially where the amount of gross business done is known, it is not definite enough for a real comparison of power costs unless a number of other pertinent factors affecting conditions are known, as well as what items of the above list are included in such costs.

To illustrate this point it may be mentioned that different types of washing machines require different quantities of water for the same load of goods. As this water is heated by steam, either live or exhaust, and as some washing machines require twice as much water per run as do others, it is evident that this condition alone will cause a wide variation in the item of fuel, so that a comparison between several laundries based on the combined steam and power costs may be quite misleading in so far as the actual power costs are concerned, unless the amount of water used per dollar of gross business is also known and is similar for each of the cases compared. Other illustrations might also be mentioned, but space will not permit.

The results of the investigation on these 32 laundries will, however, be of value when they are tabulated, and if sufficient information is secured concerning them they may furnish a fair basis of comparison between costs of purchased and generated power in general. Unfortunately, to date, information on only about a third of these has been received in sufficient detail to be of use, and a proper comparison of generated and purchased power costs is not afforded by them. It is hoped, however, that the balance of the data will be received in time to be available for those interested.

In addition to the gathering of this data on the 32 plants mentioned an actual test was made in a laundry producing most of its power by steam engine and line shaft drive, a small amount being purchased from a central-station power company to operate a few machines equipped for motor drive. A four weeks test was conducted by engine drive followed by a four weeks test driving the line shaft with a motor with central-station current. When the engine was in operation a tank of water was heated by exhaust steam, and this hot water was used in the washing machines and for feed water for the boiler. Live steam was also used in the washing machines to bring the water up to the proper temperature, and for heating the mangles, driers and other machines. When the motor displaced the engine no exhaust steam was available, and therefore no hot water, so live steam was used exclusively in heating the water in the washing machines, as well as for all other purposes.

The theoretical saving in fuel oil to account for the heat extracted by the engine in producing the power required for operations for four weeks was 6.99 bbl. If then, all of the exhaust steam produced was used, and its heat was available in the washing machine without loss, then this 6.99 bbl. of fuel oil would be all that could be saved in fuel if the plant was operated electrically. The test, however, showed a saving of 39.08 bbl. of fuel oil for the four weeks and proved that in the practical utilization of the exhaust steam over two-thirds of its heat value was wasted and not used. The amount theoretically chargeable to power production was 13.02 per cent of the fuel oil necessary to produce the steam used by the engine, and the re-

sults of the test proved that the actual amount chargeable was 72.8 per cent. The boiler efficiency during steam drive averaged 64.43 per cent and during the electric drive test 64.28 per cent, and the evaporation was 11.03 lb. of water per lb. of fuel oil during steam drive and 10.61 during electric drive. The amount of water used for washing per dollar of gross business was 13.157 cu. ft. during steam drive and 12.882 cu. ft. during electric drive, and the gross business done was $12,309.14 during the steam drive test and $12,588.58 during the electric drive test. The actual fuel oil saved was approximately 16.2 per cent of the total that would have been used for engine operation including steam for all other purposes. The power regularly purchased (2,100 kw-hr. for four weeks, which includes that used by a 10-hp. well water pump which furnished about 62 per cent of the water) represents about 29 per cent of the total power requirements, the balance (71 per cent) being produced by a St. Louis Corliss engine through line shaft drive. With individual motors the total power required for four weeks would be 5,855 kw-hr.

With fuel oil at $1.82 per bbl., the price paid, the extra power (3,755 kw-hr.) can be purchased for less than the saving made in fuel oil alone. The total annual steam and power costs as normally operated (engine drive and purchased power, including interest on investment, depreciation, maintenance, repairs, taxes and insurance on boilers, engine, line shaft equipment, motors and wiring; also engineer's salary and power bills) was $10,425.74 for a gross annual business of $163,651.54. This represents a cost of 6.37 per cent of the gross business, including fixed charges as well as all other items properly chargeable to steam and power costs. If all the power was purchased the total amount cost of steam and power would be $9,948.51, including interest, depreciation, etc., on the extra motors and wiring necessary for individual motor drive, a saving of $477.23 per year. This total steam and power cost represents 6.08 per cent of the gross business. If an engine generator set was installed and all electrical power generated the total annual minimum cost possible would be $10,749.83, or 6.57 per cent of the gross business. The saving made by purchased power is not the complete saving that would be made, as none of the intangible costs incident to power production were included in such costs, and on the other hand the bills for purchased power include everything. Then, too, the salary of the engineer ($40 per week) was figured at the same amount for all cases, whether steam alone was produced or whether steam and power (in part) was produced or whether steam and the total power used was generated. The load factor of this plant (individual motor drive) would be 20.45 per cent based on the maximum demand and 24 hours per day, 7 days per week, and based on the actual hours of operatioin (192-5/6) for the four weeks it would be 71.27 per cent. The maximum demand would figure 66.3 per cent of the rated horsepower of connected load of the individual motors required.

The washing machines in this laundry are the old type wooden ones. If the new type metal machines were installed the annual saving effected by purchased power would be at least $1,937 over generated power. The conclusions from this investigation are that at the present prices of power and fuel oil a considerable saving can be made with purchased power over any other method of operation, and that in new laundries, properly equipped, the possible saving is so large that nothing but purchased power can reasonably be considered.

Generated vs. Purchased Power in Saw Mills

The subcommittee investigating this phase of competitive power sent out questionnaires (patterned after those sent out to waste heat cement plants) to sixteen saw mills in California and one in Oregon and received five answers in reply, only one of which contained sufficient information to be of value, and even this one was not definite enough for the purpose of figuring power costs per kw-hr. In the first place the capital invested in power producing machinery was not given, hence the fixed charges could not be figured. Second, the operating and maintenance costs including repairs ($15,000 per month) covered a part of the mill not electrified (engine drive) and steam for the dry kiln, as well as the electric power producing part. Third, the kw-hr. generated were stated at 3,000 kw. per working day. This was probably intended to be an average load of 3,000 kw. per day during the time of operation, but the number of hours run per day was not given. The subcommittee figured this as approximately 1,053,000 kw-hr. per month, but they may have had further information on the subject.

The maximum demand was given as 4,000 kw., and the output of the mill at 9,000,000 ft. of lumber per month, but the kind of lumber worked was not noted. From the above the average use of power per 1,000 board ft. is 117 kw-hr., and from data at hand the average in saw mills is 27 kw-hr. for sugar pine lumber and 54 kw-hr. for redwood lumber. Where a saw mill and planing mill was combined the average with sugar pine lumber was found to be from 52 to 59 kw-hr. per 1,000 board ft., the planing mill handling a considerable portion of the output of the saw mill. Inquiry of the San Francisco office of this particular lumber company secured the information that the timber worked was principally redwood, but that some fir was also worked, and that a planing mill was operated in connection with the saw mill, in which case the 117 kw-hr. per 1,000 board ft. figured above is not unreasonable, for power consumed in redwood mills is about double that of sugar pine mills.

The findings of the committee in this instance were that this power (1,053,000 kw-hr. per month) could be purchased from the San Joaquin Light & Power Corporation under their wholesale rate for $11,577.50 or a saving of $3,422.50 per month over the operating charges noted above ($15,000) and if purchased from the California Oregon Power Company under their special lumber mill rate the saving would be about $5,000 per month. The operating charges, however, cover other operating expense besides that for electric power generation, the proper segregation not being known. The fixed charges covering electric power generation (amount not known) may or may not cover that deductible portion of the operating charges properly belonging to activities other than electric power generation. It would appear, however, that this mill if located on the lines of either of these power companies (though it is not) could purchase power at a saving if this saving was not wiped out completely by the cost of disposing of the additional lumber refuse resulting from operating the boilers only for the purpose of supplying the dry kilns with steam.

To properly get at this problem a personal investigation should be made of some representative mill, the operators of which were sufficiently interested in securing the real facts to be willing to cooperate with the investigator to the extent of lending every possible aid in securing the actual investment and operating costs from their books or records, and in making such other investigations and tests as would establish a proper basis for figuring the cost of power production and all other incidental things, that might effect the practical utilization of outside power service. Such an investigation would probably take three months continuous time of a man particularly qualified for such work. A similar investigation was made in connection with the laundry problem and resulted in the discovery of some practical facts which greatly discounted the value of exhaust steam, at least in its application in this industry. If such an investigation could be made of the saw mill problem, covering actual practical operation, something might be discovered that would upset some of the time-honored assumptions, but if not at least the actual facts would be known as well as the practical limitations of generated and purchased power in this industry, a worthwhile thing in itself.

The general findings of the committee on this subjest were as follows:

1. The information obtained was too meager to make a thorough analysis of the subject, due to the methods of accounting in use by the lumber companies which do not take into account all of the factors effecting the actual cost of generated power. Further, it is quote probable that if both the direct and indirect costs of all shutdowns incident to power generation were charged to this account the advantage would lean greatly toward central-station power on account of its greater relative dependability.

2. In most plants steam is necessary for the dry kilns and the generators are operated with surplus steam from free fuel which would otherwise have to be

disposed of in an incinerator, and under these conditions it is obviously more economical to operate an isolated generating plant than purchase central-station power.

3. In plants so located that there is a market for waste fuel or firewood for domestic consumption and where steam is not used for dry kilns, it is more economical to buy central-station power than to operate an isolated plant.

4. The ideal arrangement for the lumber companies is to maintain a generating plant the size of which should be governed by the reserve capacity of the boilers in relation to the average available fuel (waste fuel); this plant to be tied in with central-station lines under a reciprocal agreement governing input and output, to guarantee continuity of service.

5. It is more economical to buy central-station power for logging operations.

6. The power salesman's best line of approach and contact is upon the point of continuity of central-station service. Other arguments depend largely upon local conditions.

Copies of this report in full with answers received to questionnaires will be available to member companies.

Generated vs. Purchased Power in Large Hotels

More and more hotels are being converted to central-station current throughout the country due to the economies in engine room operation that can be secured by this method only. This tendency is more noticeable in the East than in California, probably due to the hot summers which make exhaust steam of no value whatever during that season. The value of exhaust steam in hotels, however, is much over-estimated, for as a particular matter of fact large quantities of it are usually wasted where plants are operated non-condensing due to the fact that the heating demand curve does not parallel the power and lighting demand curve. Where part of the machines are operated condensing in order to save this loss, the power thus generated costs considerably more than purchased power, though not as much more as it would with non-condensing machines where the exhaust is wasted. The greatest economy, however, is secured through the much lower operating and maintenance costs of electrically driven auxiliaries over the steam driven ones, and the saving effected by the absence of a lot of machinery and a maze of steam pipes which require costly attention and occupy valuable space. Then, too, operating the boilers at low pressure for steam heating also effects a saving over high pressure boilers using reducing valves for this purpose, so if exhaust steam is no longer used the pressure on the boilers should be reduced to 5 or 6 lb. gage. If a small quantity of high pressure steam is necessary an auxiliary boiler should be operated for this purpose.

A temporary report was made on the operations of a very large hotel in San Francisco about two years ago (when fuel oil was $1.20 per bbl.) in which the approximate saving to be made with purchased power and low pressure steam for heating (all auxiliaries to be operated electrically) was figured to be at least $5,600 per year. Had it been possible to make an actual test the saving would have been greater as it was assumed that all the exhaust was used for heating. The report was made in the month of January when this probably was the case but in later months following large quantities of exhaust steam were observed to be escaping into the air. An eastern engineering concern estimated the cost of changing over the plant at $50,000, and stated that they were willing to guarantee an annual saving of $35,000 if allowed to direct the operation of the plant, for which they asked a fee of $3,600 per year in addition to the cost of the change.

The findings of this subcommittee are that no new hotels are putting in electric power generating plants. That the cost of power in hotels with plants under 300-kw. capacity is not less than 3 cents per kw-hr. and that central-station current for hotels having a demand of over 150 kw. can be purchased for less. That for larger installations the cost of generation is considerably less, and that in one installation of 900-kw. capacity the cost with fuel oil at $1.65 per bbl. was 1.45c per kw-hr. or over, but that central-station current was available at quite a bit less than this figure. That the main reason for not purchasing power lies in the apparent economy in the use of exhaust steam for heating and laundry work, but that this advantage is more apparent than real. Finally, that in hotels having power producing machinery in operation they are likely to continue generating during the useful life of that apparatus, as it has hardly more than junk value for any other purpose.

It is this latter fact that makes it hard to convert existing plants, especially as additional outlays are usually necessary to effect economies of operation with the adoption of purchased power, yet as existing plants get older they become less economical and repairs become more costly and an investigation of actual conditions will often reveal the fact that it would pay to junk the plant long before it actually wears out.

Copies of this subcommittee's report will also be available for distribution.

Large Diesel Engine Installations

The subcommittee having this subject in charge was so busy on other subjects that no time was available for an investigation of this one and no report was made.

The Diesel engine, on account of its large first cost, and consequently its much greater fixed charges, will show its most economical costs per unit of output at high load factor. Such high load factor is offered by the ice making industry, the machines for the manufacture of which are operated 24 hr. per day for usually eleven months per year. If, then, the Diesel engine is at all a serious competitor of central-station power it would demonstrate that fact most effectively in its application to power production in this industry.

The results of the investigations of an independent engineer for the benefit of those interested in ice making are given herewith and they apply to a 100-ton, high-pressure, raw-water ice plant producing 32,000 tons per year and operating with 1,600 300-lb. cans and 35,000 ft. of 1¼-in. pipe, 4-can lift, automatic fill, and 10,000-ton season ice storage. The results include energy at 1½ cents per kw-hr., coal at $4.50 per ton delivered, and fuel oil for the oil engines at 5 cents per gal. delivered.

Type of Plant	Total Yearly Mfg. Cost	Yearly Power & Fuel Cost	Per Cent Power or Fuel to Total Mfg. Cost
Motor-driven	$69,630	$22,100	32.0
Uniflow steam Engine-driven	74,932	9,300	12.5
Full Diesel oil Engine-driven	74,362	8,800	11.9
Semi-Diesel oil Engine-driven	76,294	11,160	14.7

From the above it will be noticed that with motor drive and central-station current the yearly manufacturing cost is the least, but the percent the power bills bear to the total expense is more than double the ratio of fuel expense to total expense of the steam and Diesel engines. The fuel expense of course is not the total expense of power for either the steam, Diesel or semi-Deisel engines, but machinery salesmen, especially of the oil engine variety, try to make it appear that way in their unfair comparison of fuel costs with central-station power costs, and it is this that impresses the uninformed rather than any actual competitive value they might possibly possess.

The cost per ton of ice manufactured, which includes operating costs and fixed charges, water, ammonia, storage, etc., is as follows:

Motor-driven plant	$2.17 per ton
Uniflow steam engine-driven plant	2.34 per ton
Full Diesel oil engine-driven plant	2.32 per ton
Semi-Diesel oil engine-driven plant	2.38 per ton

In the cost for motor drive purchased power was figured at 1½ cents per kw-hr. If this plant was on the line of the Pacific Gas and Electric Company it would earn an average rate of 9.4 mills per kw-hr., and the annual cost of power instead of being $22,100 would have been $13,839.60. The cost per ton of ice would therefore have been $1.92 with purchased power, the other items entering into manufacturing costs remaining the same—such as labor, investment, water, ammonia, etc.

The opinion of this subcommittee is that the Diesel engine is not a real competitor of central-station service where rates as low as those in effect here are available and the service is dependable.

The Industrial Application of Electric Heat

Report of Subcommittee on Industrial Heating, Power Bureau, Commercial Section*

THE following is a composite report of the work of the members of this subcommittee, but cannot adequately cover the papers prepared by the committee members on the individual subjects assigned to them. The following papers have been mimeographed and are available for those who desire them:

Baking Cores by Electric Heat	E. J. Cipperly
Using Electricity for Heat Treating	E. J. Cipperly
Commercial Electric Cooking	T. A. Reid
Electric Melting and Refining of Iron	E. A. Wilcox
Electric Brass and Bronze Melting Furnaces	E. A. Wilcox
Electric Welding	F. O. Sievers
Electric Japanning Ovens	W. G. Tanner
Arc Heating of Steel	E. V. Kane
Electric Dehydration	W. W. Hicks
Vitreous Enamelling	H. A. Mulvaney

Without doubt the most spectacular application of industrial heating is the arc furnace. In the steel industry the arc furnace is taking a more and more prominent place—there being in excess of 100 electric furnaces in steel casting foundries in the United States. For the production of special steels and alloys the electric furnace is without a peer, there being in excess of 75 electric furnaces in this class of work. The United States census credits California with the production of 97,000 tons of steel in 1923, while slightly less than 7 per cent, or 7,000 tons, were produced in electric furnaces. In the United States that year 500,000 tons of steel were produced electrically, this being but one and one-half per cent of the total steel production.

If the census figures are correct, the existing electric furnace installations are a possible outlet for 175 million additional kw-hr. annually in California.

The amount of steel produced electrically, while a small part of the total, is increasing at a faster rate than the total production. Because of the ease and certainty of control of the factors which determine good steel and perfect castings, electric steel furnaces will continue to be the major application of electricity to industrial heating.

In melting and refining of iron, the electric arc furnace has already established itself in those fields where high quality of iron castings is demanded, and in this field, high quality has been attained at costs which compare favorably with the costs in cupola practice. The electric furnace makes available scrap which cannot be used in the cupola; prevents contamination from the fuel; makes possible close analysis of each heat, insuring a uniform product, and the temperature may be adjusted to any desired point to meet the exacting requirements of intricate castings without resorting to the excessive use of phosphorous with its deleterious effects. It is particularly interesting to note that with electricity costing seven or eight times more than coke, the electric furnace can frequently deliver a better quality product to the ladle at a lower cost than the cupola—this because of the saving in cost of the metal charged, and the lower melting loss and labor costs.

The electric furnace is particularly well adapted to the production of malleable castings. The charging, tapping and testing, with the electric furnace, are easily done; heats may be held for hours without injury to the furnace or metal, temperature and anlysis may be accurately controlled with less expensive charges, and a better grade of malleable casting is more readily produced. It is quite possible that because of the better grade of iron castings, and the consequent wider use, the arc furnace in melting and refining of iron will enjoy a more general application than exists in the steel industry.

The progress of the electric furnace in melting brass and bronze has been more rapid than in the iron and steel industry. Three types of furnaces are in use, with the field rapidly narrowing down to two. The indirect arc type is used for those applications where the furnace is used intermittently, or where the analysis must be varied frequently. There are 135 furnaces of this type in use in the United States. For those applications where there is continuous production and infrequent change in analysis, the induction furnace has been extensively installed, there being 275 of this type in the United States. The other type referred to obtains its heat from a granular resistor material, and the heat is reflected to the metal from the walls and roof of the furnace.

There are many reasons why the electric furnace has become so well established in this industry, among the more important being: low melting losses, large capacities, uniformly well stirred product, close control of anlysis and heat, saving in space, better working conditions and lower labor costs.

Another use of electric heat in the foundry is in baking cores. Last year when some installations of electric core baking were changed to gas on account of the power shortage in some sections, production and quality of core were lowered, and the chance to return to electric baking was welcomed. The automatic control and even distribution of heat possible in the electric oven, makes it particularly well suited to this class of work. This should prove a profitable field for active work on the part of power and oven salesmen, and this to the distinct advantage of the foundryman.

The fallacy of comparing the value of various fuels on a B.t.u. basis is particularly well illustrated in the heat treating processes where electricity, because of the high efficiency in application, the reduction of discards, the elimination of straightening and cleaning operations, and the improvement of the product, make it the most economical source of heat in the majority of cases. This does not take into consideration the practical elimination of shut-downs for repairs, and the comfortable working conditions for employees. The load, which is usually on the line from 10 to 24 hr. each day, is practically non-inductive; is a very attractive one for central stations and is one which can be safely sold with assurance that the installation will stay sold.

The field of electric welding has broadened rapidly during the past few years. The portable motor or engine-driven welding sets have made possible the use of arc welding at inaccessible places, and the development of automatic welding machines has improved the quality of work and made possible the welding of thin materials formerly thought impossible. The paper on this subject contains some valuable tables on current consumption and welding speeds for different kinds of work.

The use of electricity in japanning ovens is a matter which should receive careful consideration in each installation involved. Oil fired equipment has replaced electricity in some of the larger installations, but there seems to be a legitimate field for electric japanning ovens and these make very desirable loads. One company sold six japanning ovens in 1924, totaling 339 kw. and five varnish drying ovens with an aggregate capacity of 325 kw.

In the field of commercial cooking, the importance of the efficiency of the application has made possible a rapid expansion in the use of electricity. Restaurants, hotels and hospitals are using ranges, griddles, broilers, etc., in increasing numbers, and the canning industry is using electricity in some cooking processes to a marked advantage and at an overall cost which is actually lower than for fuel fired equipment. For baking bread and pastries, there is a wide range of dependable equipment available. The higher cost of electric heat is more than returned in decreased shrinkage, a barrel of flour actually producing more loaves of bread of a given weight than can be secured from fuel fired ovens. Add to this the increased production from a given size of equipment, better quality of product because of accurate control, cleanliness, improved working conditions, safety, saving in floor space and long life of equipment, and we have a very desirable piece of equipment for the consumer. This class of business has enjoyed a healthy growth during the past year.

The increased use of electric heat for vitreous enamelling has been hampered during the past year on the Pacific Coast by an unwarranted amount of publicity which has been given to some oil-fired oven experiments at a plant where a large part of the work had been done in electric furnaces. While some earlier types of electric furnaces have been displaced, the oil-fired equipment has not been in operation long enough to give

* John L. Farley, Pacific Gas and Electric Company, chairman; E. J. Cipperly, General Electric Company; T. A. Reid, Westinghouse Electric & Manufacturing Company; H. A. Mulvaney, Electric Sales Service Company; E. A. Wilcox, E. A. Wilcox Company; F. O. Sievers, General Electric Company; W. G. Tanner, Southern California Edison Company; E. V. Kane, L. A. Bureau of Power and Light; W. W. Hicks; W. L. Boxall, Southern California Edison Company.

conclusive results, and the furnace linings have already given trouble. It is believed that this experiment will reflect favorably on the application of electricity to this class of work. The two large duplex electric tub furnaces in the plant referred to are not being replaced, nor is such a move being planned at this time.

In the dehydration of fruits, some experiments have been conducted which are very favorable to the use of electric heat, especially for nuts where close regulation produces a superior product. This summer an experiment is to be conducted which should give some very valuable data. Two dehydrators, side by side and of the same size, and with the same attendants, one fuel fired and the other with electric heat, will be operated during the season. The dehydrating load is a very desirable addition to the agricultural load, both for the consumers and for the power companies, as it comes on at the close of the pumping season.

Another agricultural load which should claim the attention of central-station men is the hatching and brooding of chickens. Last year 22,000,000 chickens were hatched commercially in California. If this had all been done electrically, from 11,000,000 to 40,000,000 kw-hr. would have been consumed. One of the most attractive features of this equipment is that the power cost in the more efficient equipment is actually less than the fuel cost in oil equipment. Add to this the elimination of the fire hazard, and reduced attendance costs, and we have an appliance which is unusually attractive to the consumer. This device must receive practically uninterrupted service, and the fear of a shut down is one of the chief obstacles in the sale of this equipment. Incubators are not as exacting in their requirements as brooders. When the chickens are young and the weather cold, a fifteen to thirty-minute interruption in service would be disastrous. This load comes on late in December and continues through May.

With the improved equipment which is rapidly becoming standardized, and with the favorable rates available on the Pacific Coast, the application of electric heat to the industries is destined to be the major load supplied by central stations.

Electric Transportation and the Central Station

Report of Transportation Bureau*

THE Transportation Bureau has devoted much of its effort to the preparation of three series of letters calling the attention of executives, new business men and transportation and construction men to the advantages to be gained by using and sponsoring the use of electric trucks.

The bureau has also succeeded in arranging for an Electric Vehicle School to be held in San Francisco the week prior to the June convention of the National Electric Light Association. Through the activities of the bureau better team work among the truck and battery representatives, truck users and central stations has been brought about, tending toward a more unified and intensive sales effort.

The Electric Street Truck Committee has made a study of truck operation in comparison with gasoline truck operation and has developed some very interesting facts.

The Industrial Truck and Tractor Committee in reporting on the use of this equipment calls attention to present applications and to the large potential field for further use.

Recommendations

The Transportation Bureau as a result of its activities makes the following recommendations:

1—That the electric utilities very seriously consider the advantages to be gained by the use of electric trucks, which will result not only in a reduction of their own transportation costs, but also in the encouraging of other concerns to use electrics.

2—That a new committee under the jurisdiction of the Transportation Bureau be established to study transportation problems and operating costs of all equipment both gasoline and electric used by the electric utilities with a view of mutual aid in improving operating efficiency.

3—That a survey be made of Pacific Coast conditions to determine the percent of the total trucks in use that do work which could be handled by electrics.

4—That a detailed study be made of industrial truck and tractor applications and that articles dealing with special and unique applications be prepared for trade publications.

5—That an Electric Transportation Association modeled along the same lines as the one now existing in San Francisco be formed in Los Angeles to bring together for the promotion of common interest the truck and battery distributors, central station representatives and electric truck operators.

Educational Letters

The Transportation Bureau as a whole has devoted considerable effort toward the preparation of three series of letters designed to further interest the electric utility executives, new business men and transportation and construction men in the electric truck. These letters have been segregated into three series, the first of which consists of 13 letters to company executives, outlining the results that the electric utilities will realize by using and actively promoting the use by their consumers of electric trucks. The second series consisting of 12 letters are being sent to new business men and cover the reasons that the battery charging load is so ideally situated to improve the daily load curve and to yield such a high net revenue to the power companies. These letters suggest the value of designating an individual or bureau to specialize in encouraging the use of electric street and industrial trucks. The third series of 10 letters go to transportation and construction men who are primarily interested in economy and reliability of the trucks operated by the power companies themselves. For this reason great stress is laid upon the economy of operation, the ease of handling and the continuous service which the electric truck will show.

Figs. 1 and 2 show reproductions of several of the various letters which have been sent out. The appendix to this report contains the complete series sent to central station executives.

Electric Vehicle School

The bureau has arranged with the Transportation Bureau of the National Electric Light Association and its Electric Vehicle School Committee to have a school held in San Francisco the week prior to the National Electric Light Association convention. This school is to be similar to the one held in San Francisco two years ago and to those which have been held from time to time in New York, Boston, Chicago and other Eastern cities. This school, which lasts for one week, covers all aspects of the electric truck, including its construction, operation, battery construction and charging, transportation engineering and the selling of the trucks. The former schools have been attended by central station representatives and by operators of electric trucks. An attendance at the coming school of at least 40 is anticipated, and it is hoped that last minute enrollments will bring the number considerably above this.

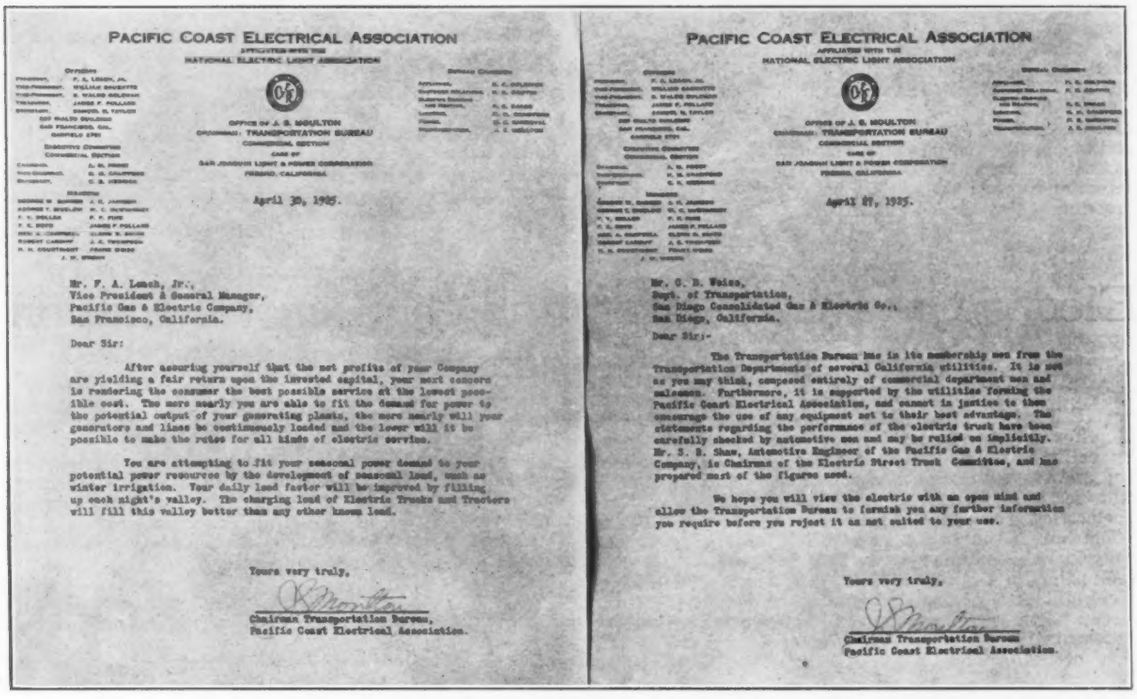
*Transportation Bureau, Commercial Section.—J. S. Moulton, chairman, San Joaquin Light & Power Corporation; S. B. Shaw, vice-chairman, Pacific Gas and Electric Company; W. W. Willits, secretary, Los Angeles Gas & Electric Company.

Electric Truck Committee.—S. B. Shaw, chairman, Pacific Gas and Electric Company; Peter Ducker, Southern California Edison Company; J. L. Farley, Pacific Gas and Electric Company; Harry Easterbrook, Westinghouse Electric & Manufacturing Company; Ed. Hunt, General Electric Company; W. J. Shaeffer, Los Angeles Gas & Electric Company; H. N. Sessions, Southern California Edison Company; A. J. Theis, Pacific Gas and Electric Company; C. D. Weiss, San Diego Consolidated Gas & Electric Company; E. C. Wood, Pacific Gas and Electric Company.

Industrial Truck Committee.—Ira G. Perin, chairman, Elwell Parker Company; D. L. Hicky, Pacific Gas and Electric Company; H. C. Rice, Southern California Edison Company; W. W. Willits, Los Angeles Gas & Electric Company; H. B. Cleveland, Gunn Carle Company; Henry Boone, Industrial Supply Company; G. F. Wakeman, Edison Storage Battery Company; E. Kower, Electric Storage Battery Company.

Unification of Sales Effort

The bureau has through its committees brought together the various individuals and firms interested in the promotion of electric trucks and tractors with the result that as the various individuals have become better acquainted their cooperation toward increasing the use of electrics has been improved. The Transportation Bureau has done very valuable work in this connection and firmly believes that it has been a considerable assistance to the various interests in covering the broader aspects of electric vehicle promotion.



PACIFIC COAST ELECTRICAL ASSOCIATION

AFFILIATED WITH THE NATIONAL ELECTRIC LIGHT ASSOCIATION

OFFICE OF A. S. MOULTON
CHAIRMAN, TRANSPORTATION BUREAU
COMMERCIAL SECTION
CARE OF
SAN JOAQUIN LIGHT & POWER CORPORATION
FRESNO, CALIFORNIA

April 30, 1925.

Mr. F. A. Leach, Jr.,
Vice President & General Manager,
Pacific Gas & Electric Company,
San Francisco, California.

Dear Sir:

After assuring yourself that the net profits of your Company are yielding a fair return upon the invested capital, your next concern is rendering the consumer the best possible service at the lowest possible cost. The more nearly you are able to fit the demand for power to the potential output of your generating plants, the more nearly will your generators and lines be continuously loaded and the lower will it be possible to make the rates for all kinds of electric service.

You are attempting to fit your seasonal power demand to your potential power resources by the development of seasonal load, such as winter irrigation. Your daily load factor will be improved by filling up each night's valley. The charging load of Electric Trucks and Tractors will fill this valley better than any other known load.

Yours very truly,

Chairman Transportation Bureau,
Pacific Coast Electrical Association.

PACIFIC COAST ELECTRICAL ASSOCIATION

AFFILIATED WITH THE NATIONAL ELECTRIC LIGHT ASSOCIATION

OFFICE OF A. S. MOULTON
CHAIRMAN, TRANSPORTATION BUREAU
COMMERCIAL SECTION
CARE OF
SAN JOAQUIN LIGHT & POWER CORPORATION
FRESNO, CALIFORNIA

April 27, 1925.

Mr. C. B. Weiss,
Supt. of Transportation,
San Diego Consolidated Gas & Electric Co.,
San Diego, California.

Dear Sir:-

The Transportation Bureau has in its membership men from the Transportation Departments of several California utilities. It is not as you may think, composed entirely of commercial department men and salesmen. Furthermore, it is supported by the utilities forming the Pacific Coast Electrical Association, and cannot in justice to them encourage the use of any equipment not to their best advantage. The statements regarding the performance of the electric truck have been carefully checked by automotive men and may be relied on implicitly. Mr. S. B. Shaw, Automotive Engineer of the Pacific Gas & Electric Company, is Chairman of the Electric Street Truck Committee, and has prepared most of the figures used.

We hope you will view the electric with an open mind and allow the Transportation Bureau to furnish you any further information you require before you reject it as not suited to your use.

Yours very truly,

Chairman Transportation Bureau
Pacific Coast Electrical Association.

Fig. 1—Samples of some of the letters sent out by the Transportation Bureau

Revenue from Charging Load

Many users of electric trucks are also large users of power for other purposes and receive their total supply through one meter. For this reason, the revenue from battery charging for the various companies cannot be obtained exactly. The approximate revenue received and the number of trucks charged by each of the California utilities is shown in Table I. The 556 street trucks yield a revenue of $85,120, while industrial trucks probably add $40,000 to this, making a total of $125,120. The growing importance of the charging load is readily apparent from these figures. When it is further noted that practically all of this power is off peak, the high net revenue received demands serious thoughts as to how this load may be increased.

Table I—Revenue from Battery Charging of Electric Street Trucks

Company	No. Trucks Charged	Annual Revenue	
Bureau Power and Light	74	$13,300	(Approx.)
Great Western Power Company	58	8,350	"
L. A. Gas and Electric Company	251	39,800	"
Pacific Gas and Electric Company	104	15,000	"
S. D. Cons. Gas & Electric Company	2	360	"
San Joaquin Light & Power Corp.	20	1,840	(Exact)
Southern California Edison Company	38	5,470	(Approx.)
Southern Pacific Company	2		
Western States Gas & Elec. Company	7	1,000	
Total	556	$85,120	

ELECTRIC STREET TRUCKS

The application of the electric street truck to the transportation problem of the Pacific Coast cities has seemed to lag somewhat behind that of the larger Eastern cities of the United States.

There are several reasons for this, among which the following are probably the most important:

1—Traffic Density. The density of street traffic has not been so heavy in Western cities as in the larger Eastern cities, and for this reason the gasoline driven vehicle has not been handicapped to the extent that it has been where traffic is more dense.

2—Density of Population. The density of population is also greater in the Eastern cities than in those of the Pacific Coast. The greater the density of population, the more frequent will be the stops on delivery routes, and the shorter the hauls for general transportation purposes.

3—Street Conditions. The Western cities having grown quite rapidly in the past few years, have perhaps not been so extensively paved with hard, smooth pavements as those of the East. This element has probably worked a deterrent influence upon the use of electric trucks on the Pacific Coast to a certain extent.

4—Hills. Most of the larger Western cities are quite hilly. Some of the earlier models of electric trucks sold for use here were not properly engineered for hill work, and proved to be very slow on grades, resulting in a feeling among many users that the electric truck would not operate satisfactorily where hills were involved.

5—Lack of Promotion. The electric truck has not in the past been promoted on the coast by the power companies and the truck manufacturers to the extent that it has been in the East. On the other hand, gas truck sales have been pressed by a large number of very active manufacturers and dealers and the field has been well developed. This field has been increased greatly by the development of the California highway system, a large number of trucks having been sold for use in country and inter-city work.

Trucks In Operation

In spite of the deterrent influences mentioned, the electric truck has made considerable progress on the Pacific Coast. In California as of Mar. 1, 1925, there were in operation in this state 66 electric truck fleets, varying in size from 1 to 89 trucks each. The size of the trucks used varied from ½ ton to 9½ tons capacity. In Table II there is shown the distribution of electric trucks in California, according to capacities and the various industries by which they are used.

It will be noted that the largest users are those industries where the delivery problem is one of the most important elements of the business. That is, where regular house to house or store to store routes with frequent stops are involved. It is in this field that the electric truck can most easily demonstrate its super-

Table II—Distribution of Electric Trucks in California by Sizes and Industries Mar. 1, 1925

	½ & ¾ Ton	1 Ton	2-2½ Ton	3-3½ Ton	5 Ton & over	Totl
Ice cream		1	12	13	2	28
Creameries and dairies	20	131	48	1		200
Laundries	29	6				35
Ice companies	2	9	17			28
Baking companies	2	83	41	2	1	129
Express companies		2	12	2	4	20
Department stores	18	11	5			34
Mercantile stores		5	7	1	1	14
Public utilities	4	7	27	2	2	42
Soft drink manufacturers		1	4	3	1	9
Grain and milling				4		4
Municipalities	1		2	1		4
Miscellaneous			5		4	9
Total in use Mar. 1, 1925	76	256	180	29	15	556

iority over all forms of transportation for the reason that under such conditions, the electric truck can maintain a higher average speed, and do so without any material increase in its operating costs as compared with the rapid increase in operating costs of gasoline driven vehicles when an effort is made to obtain speed where a larger number of starts and stops are necessary.

Table III lists by capacities and the name of the user all electric trucks in California. It is to be noted that of the 556 trucks in use, the 1-ton and 2-ton sizes predominate, 436 or 78.5 per cent being of these sizes.

Advantages of Electrics

As indicated above, increasing traffic density has a tendency to force the use of electric trucks as it has done in the large Eastern cities. Increased traffic density results in a general slowing down of all traffic, particularly as with this increased density there are necessarily a greater number of traffic stops to be made. The difficulty of finding parking space for delivery purposes is also increased. Under these conditions, the electric truck gains an advantage over the gasoline driven vehicle. There being no gears to shift, more rapid acceleration can be obtained, and the truck is more flexible to operate under conditions of constantly changing speeds. Furthermore, for trucks of equal capacity, the electric vehicle can be parked in a shorter space along side curbs for making deliveries, and there is, therefore, less time lost in locating available parking space.

The effect of traffic and frequent stops in reducing the average speed of motor vehicles is shown by certain investigations recently conducted in San Francisco. While the routes involved in these investigations included but a small portion of traveling in the more congested districts, and the number of stops other than for traffic interference averaged about one for every mile, it was found that the electric truck having a maximum speed of 14 miles per hour was able to attain approximately the same average speed as gasoline driven vehicles having maximum governed speed of 20 miles per hour. As the number of stops per mile is reduced, the gas truck might gain a slight advantage in speed over the electric truck, provided that traffic conditions permitted the use of the higher speed. On the other hand, as the number of stops per mile is increased, the electric truck soon gains a decided advantage in average speed. This increase in the average speed makes it possible for the electric truck to cover a given route in a shorter period, or a longer route within a given time.

The results of the comparative speed tests referred to, are shown in Table IV. In making these tests, the electric and gasoline trucks used were all of the same capacity—2 tons, and carried approximately full load at all times. Both trucks covered the same ground each day, making the same stops in the same order, although they did not always travel between stopping points by exactly the same routes. For instance, on one occasion, the gasoline truck traveled a considerable distance round a hill, whereas the electric truck went up one side of the hill and down the other. A "Servis Recorder" proved to be a very convenient device for obtaining this data. The routes were mainly through the residential districts and grades as high as 15 per cent were encountered.

It will be noted from the table, that the average speed of the gas trucks for the 10 days involved was 11.1 mi. per hr., and that of the electric trucks 12.1 mi. per hr. On account of the somewhat greater distance traveled by the gas trucks, and the slightly greater average speed of the electric trucks, the total time required by the gas trucks was 3 hr. more than the electric trucks. It will also be noted that the daily

Table III—Electric Trucks In California

	½-¾ Ton	1 Ton	2 Ton	3 Ton	5 Ton	Totl.
Fresno						
Benham Ice Cream Co.			3	3		6
Jersey Farm Dairy		5				5
Peoples Ice Corp.			2			2
San Joaquin L. & P. Corp.	3	2	2			7
Subtotal	3	7	7	3		20
Long Beach						
Long Beach Dairy Co.		3	7			10
Mountain View Dairies	1	6	1			8
Subtotal	1	9	8			18
Los Angeles						
Alfreds Ice Cream Co.			2			2
Autocar Sales & Serv Co.			2			2
Bishop & Co.			2			2
Buffalo Brewing Co.		1	1	1		3
Bullock Dept. Store	11		1			12
Burr Creamery		46	10			56
Broadway Dept. Store	7	1	2			10
Caledonia Laundry	6					6
California Laundry		4				4
Capitol Milling Co.				2		2
Christopher Ice Cream					2	2
Cocoa-Cola Bottling Co.			1	2		3
Crescent Creamery			10			10
Le Duxe Laundry	10					10
Electric Vehicle Co.			1		1	2
Franco Am. Baking Co.		2				2
General Electric Co.			1			1
Globe Grain & Milling				2		2
Globe Ice Cream Co.			5			5
Gold Medal Creamery			2			2
O. M. Harris			2			2
Henry Creamery		3				3
Hollywood Laundry	10					10
The May Company		4	2			6
Ice Distributing Co.			4			4
H. Jevne & Co.		5	1			6
Los Angeles Creamery	3	68	18			89
L. A. Ice & Cold Storage			9			9
Los Angeles City		2	15	1		18
Los Angeles Times					1	1
Pacific Baking Corporation		38				38
So. California Tele. Co.		1				1
Union Ice Co.		2				2
White Star Laundry		1				1
Subtotal	47	178	91	8	4	328
Oakland						
Am. Railway Express			12		1	13
Golden Sheaf Remar Bkry.	1	18				19
Southern Pacific Co.			1	1		2
Subtotal	1	18	13	1	1	34
Pasadena						
City Dairy Inc.		2				2
City of Pasadena	1		1	1		3
Mission Laundry Co.	3	1				4
Pasadena Ice & Cold Stor.		7	2			9
Subtotal	4	10	3	1		18
Sacramento						
Capitol Dairy Co.	11	2		1		14
Kave and Trainor		1				1
Liberty Ice Cream				1		1
Pacific Gas and Elec. Co.	1		5		1	7
Thomson-Diggs Co.		1				1
Subtotal	12	4	5	2	1	24
San Francisco						
Am. Railway Express		2		2	3	7
Autocar Sales & Service			1			1
California Baking Corp.	1	21		1		23
Hoffman, Dan E.		1				1
Holt Bros. Co.		1				1
Nat. Ice & Cold Storage	2					2
National Ice Cream Co.			1	9		10
Old Homestead Baking		2	41	1	1	45
Pacific Gas and Elec. Co.		2	5		1	8
Pacific States Electric Co.		1	1	1		3
Pacific Box Factory					2	2
James Smith Co.					1	1
Worth, Chas. J. Co.			1			1
United Milk Co.		1				1
Subtotal	3	31	50	14	8	106
San Diego						
Cramer Baking Co.		2				2
Stockton						
El Dorado Brewing Co.			2		1	3
Gloria Ice Cream Co.		1	1			2
Hedges-Brick Co.		1				1
Holt Manufacturing Co.			1			1
Subtotal		2	4		1	7
Total all electrics in California						556

Table IV—Relative average speed of 2-ton gasoline trucks and 2-ton electric trucks*.

Date	District	No. of Stops	2 Ton Gasoline Truck Daily Miles	Time Hrs.	Av. Sp. MPH	2 Ton Electric Truck Daily Miles	Time Hrs.	Av. Sp.
6-17-24	Vicinity of 17th, Mission..	21	17.0	1.45	11.7	14.2	1.18	12.0
6-18-24	Vicinity of 22d, Fairoaks, etc.	18	20.0	1.83	10.9	16.3	1.55	10.5
6-19-24	Visitacion Valley	13	28.0	2.63	10.7	27.1	2.03	13.3
6-20-24	Visitacion Valley	13	20.0	1.88	10.6	18.3	1.52	12.0
6-21-24	Downtown, South of Market St.....	?	16.0	1.63	9.8	12.6	1.22	10.3
6-23-24	Sunset District	25	15.8	1.71	9.3	14.8	1.15	12.9
6-24-24	Sunset, Richmond and Western Addition	23	20.2	1.87	10.8	17.2	1.62	10.6
6-25-24	Western Addition and North Beach..	?	11.5	1.25	9.2	10.2	.97	10.5
6-26-24	Potrero District	?	27.0	1.78	15.2	25.0	1.75	14.3
6-27-24	Visitacion Valley	?	14.0	1.03	13.6	13.9	1.07	13.0
	Total and average..		189.5	17.06	11.1	169.6	14.06	12.1

*Note—Both trucks stopped at same points, but did not always travel by exactly the same routes between stopping points.

mileage of the electric trucks varied from 10.2 miles to 27.1 miles, a peak average ratio of nearly 3.1.

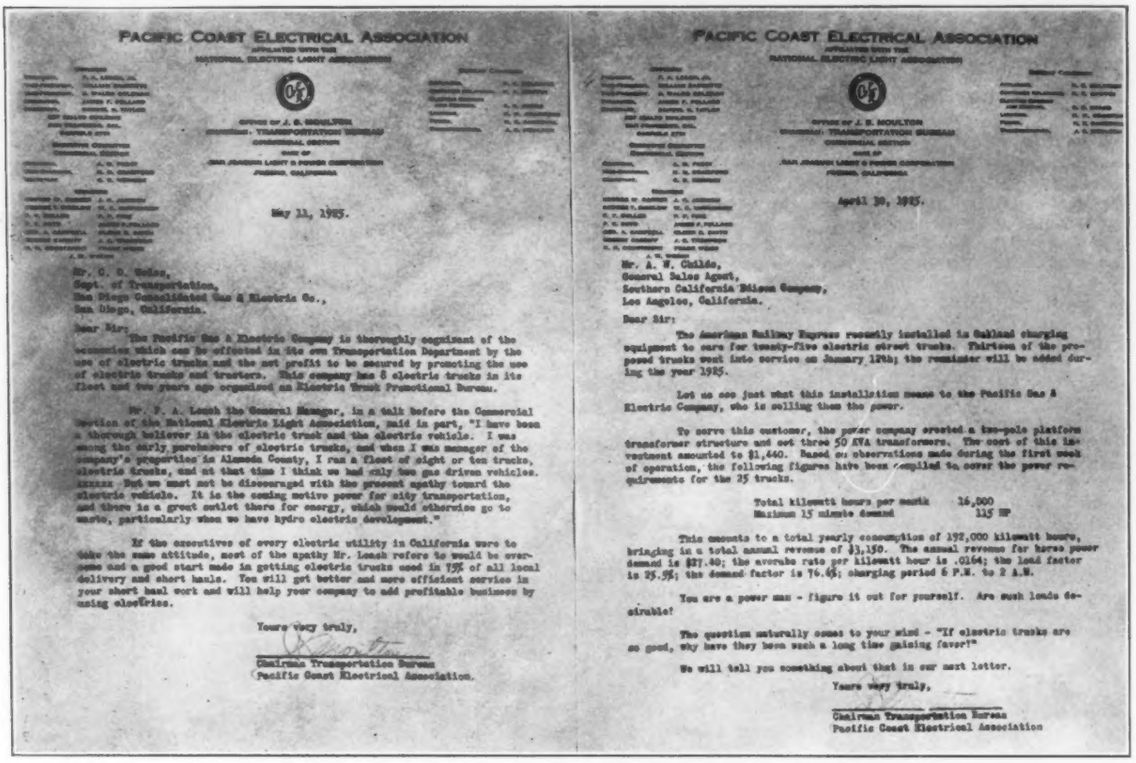
Electric Trucks on Hills

Taking up the question of electric trucks on hills, it has already been noted that the larger cities of the Pacific Coast are quite hilly. This is particularly true of San Francisco, where grades in many cases amount to 15 per cent, and in some cases to 20 per cent. In the past, the feeling has prevailed that these hills interposed an insurmountable barrier to the use of electric trucks. That this is not the case has been demonstrated by the fact that many of the electric trucks in daily use are driven over very hilly routes. The Coca-Cola Bottling Company and the Union Ice Company have each purchased two trucks particularliy for use in the Angels Flight district, the most hilly territory in Los Angeles. These have proved that an electric truck can negotiate any hill that can be negotiated by a gasoline vehicle.

Just as the ability of the gasoline driven vehicle to climb hills is determined by its engine power and gear ratio, so is the ability of the electric truck governed by the size of its motors, the drive gear ratio and the battery capacity of the truck.

Fig. 3 shows the comparative speeds which were obtained by changing the gear ratio and motor voltage of a 2-ton electric truck for various percentages in grade. The electric truck offers great flexibility of operation through the simple changes which can be made very easily and quickly. Such procedure is of considerable advantage where the use of a truck may vary considerably from week to week or month to month.

The data given in Table III indicate that the average speed of an electric truck over routes where hills are involved is practically the same as that of a gas truck. The curves shown in Fig. 4 compare the speed of a typical 2-ton gasoline truck with that of an electric truck of the same capacity that has been motored and batteried for hill work, on various grades up to 20 per cent. It should be noted that the gasoline driven vehicle is governed at slightly under 20 miles per hour, which is considered good practice, both from the standpoint of safety and economy. As indicated by the curves, the gasoline driven vehicle has considerably greater speed on the straight-away running, but when it is compelled to operate in the lower gears, it is handicapped by lack of flexibility, so that the electric truck is often able to climb hills of 5 per cent gradient and more, at a greater rate of speed than is the gas truck. When traffic conditions are involved together with hills the gas truck operates at a still greater dis-



PACIFIC COAST ELECTRICAL ASSOCIATION

May 13, 1925.

Mr. C. O. Bales,
Supt. of Transportation,
San Diego Consolidated Gas & Electric Co.,
San Diego, California.

Dear Sir:

The Pacific Gas & Electric Company is thoroughly cognizant of the economies which can be effected in its own Transportation Department by the use of electric trucks and the net profit to be secured by promoting the use of electric trucks and tractors. This company has 8 electric trucks in its fleet and two years ago organized an Electric Truck Promotional Bureau.

Mr. P. A. Leach the General Manager, in a talk before the Commercial Section of the National Electric Light Association, said in part, "I have been a thorough believer in the electric truck and the electric vehicle. I was among the early purchasers of electric trucks, and when I was manager of the company's properties in Alameda County, I ran a fleet of eight or ten trucks, electric trucks, and at that time I think we had only two gas driven vehicles. [illegible] But we must not be discouraged with the present apathy toward the electric vehicle. It is the coming motive power for city transportation, and there is a great outlet there for energy, which would otherwise go to waste, particularly when we have hydro electric development."

If the executives of every electric utility in California were to take the same attitude, most of the apathy Mr. Leach refers to would be overcome and a good start made in getting electric trucks used in 75% of all local delivery and short haul. You will get better and more efficient service in your short haul work and will help your company to add profitable business by using electrics.

Yours very truly,

Chairman Transportation Bureau
Pacific Coast Electrical Association.

PACIFIC COAST ELECTRICAL ASSOCIATION

April 30, 1925.

Mr. A. W. Childs,
General Sales Agent,
Southern California Edison Company,
Los Angeles, California.

Dear Sir:

The American Railway Express recently installed in Oakland charging equipment to care for twenty-five electric street trucks. Thirteen of the proposed trucks went into service on January 12th; the remainder will be added during the year 1925.

Let us see just what this installation means to the Pacific Gas & Electric Company, who is selling them the power.

To serve this customer, the power company erected a two-pole platform transformer structure and set three 50 KVA transformers. The cost of this investment amounted to $1,640. Based on observations made during the first week of operation, the following figures have been compiled to cover the power requirements for the 25 trucks.

Total kilowatt hours per month 16,000
Maximum 15 minute demand 115 HP

This amounts to a total yearly consumption of 192,000 kilowatt hours, bringing in a total annual revenue of $3,150. The annual revenue for horse power demand is $27.40; the average rate per kilowatt hour is .0164; the load factor is 25.5%; the demand factor is 76.6%; charging period 6 P.M. to 2 A.M.

You are a power man - figure it out for yourself. Are such loads desirable?

The question naturally comes to your mind - "If electric trucks are so good, why have they been such a long time gaining favor?"

We will tell you something about that in our next letter.

Yours very truly,

Chairman Transportation Bureau
Pacific Coast Electrical Association

Fig. 2—Samples of some of the letters sent out by the Transportation Bureau

advantage, as it is difficult to make the necessary gear shifts to obtain the highest possible operating speed on the grade.

Future of Electric Trucks

Referring to the question of street conditions, it may be said that these are being rapidly improved and a greater percentage of hard, smooth paving is being

used in connection with city streets.

In addition to this, certain truck manufacturers are now furnishing equipment which is provided with under-axle clearance equal to that of the gasoline driven vehicles, so that in case the streets are in particularly bad shape in certain seasons of the year equipment of that type can be used.

Referring to the question of lack of promotion which has existed in the past in connection with the electric truck, it may be stated that the past two years have been marked by the entrance of a number of manufacturers' representatives who have been very active in promoting the sales of electric trucks. The Transportation Bureau is also reaching the close of its second year of existence. The power companies also have taken a more active interest in this work. The results of this greater activity in sales promotion are beginning to be felt.

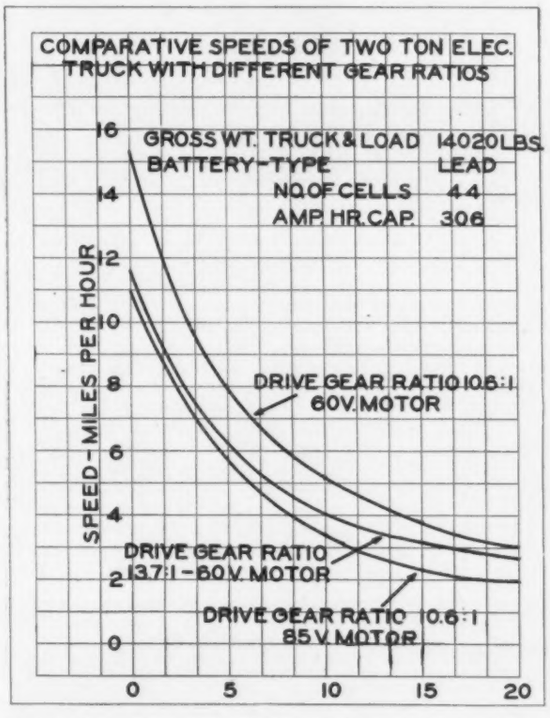

COMPARATIVE SPEEDS OF TWO TON ELEC. TRUCK WITH DIFFERENT GEAR RATIOS
GROSS WT. TRUCK & LOAD 14020 LBS.
BATTERY-TYPE LEAD
NO. OF CELLS 44
AMP. HR. CAP. 306
SPEED-MILES PER HOUR
DRIVE GEAR RATIO 10.5:1 60V. MOTOR
DRIVE GEAR RATIO 13.7:1 - 60 V. MOTOR
DRIVE GEAR RATIO 10.6:1 85 V. MOTOR
0 5 10 15 20

Fig. 3—Comparative speeds of 2-ton electric truck with different gear ratios

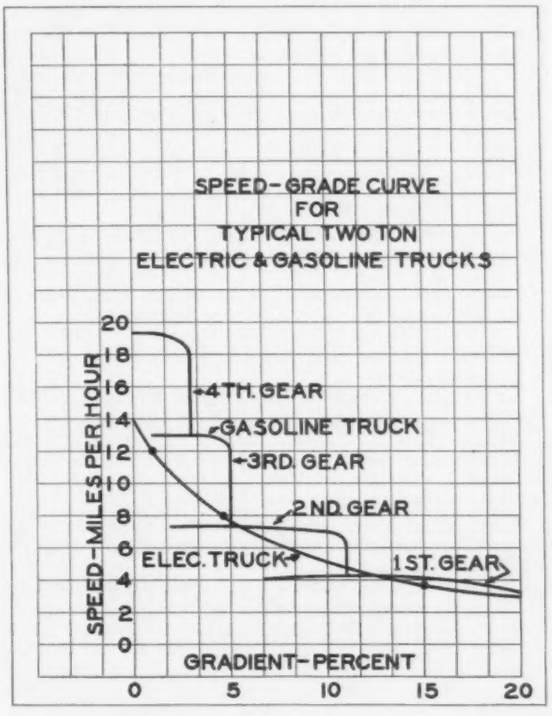


Fig. 4—Speed-grade curve for typical 2-ton electric and gasoline trucks

While the field to which the electric truck is most readily applicable is that already mentioned, the regular frequent-stop delivery route, there is a wide field for its application in non-route general delivery work, and other classes of short-haul work, particularly where traffic density is heavy.

On this latter class of work, particular attention must be paid to the selection of battery equipment, in order to provide for the peak-day's mileage. The ratio of peak-day's mileage to average daily mileage may be as great as 3.1. Furthermore, unless the vehicle can be given a boosting charge during the day, it must be equipped with a battery of ample capacity for the peak-day's work. Much of the work of power companies and other public utilities is in this class, which has to a considerable extent accounted for their apparent unwillingness to use electric trucks in their own service. However, time and experience, together with a careful study of the transportation problem with respect to possible zoning and routing of work, should indicate that a considerable portion of their work can be done more economically with the electric truck than with other types of transportation equipment, particularly in larger centers of population.

While the year 1924 was one in which the transportation facilities of California industries were not expanded very extensively, the electric truck field of application was somewhat broadened by the entrance of a number of new users. Perhaps the most notable among these was the American Railway Express Company. Although that company had probably been the largest user of electric trucks in the world, they had not used them in California until they made their initial installation of thirteen electric trucks at Oakland.

The Pacific Telephone & Telegraph Company also, while not undertaking the use of electric trucks on the same scale as the American Railway Express Company, has after a careful study of their application to its work placed electric trucks in service for observation.

A number of other potential users have manifested considerable interest in the electric truck, and may conclude to make their initial trials at any time.

Among the power companies, the Pacific Gas and Electric Company has continued its investigation of transportation operations and has increased its electric truck fleet, as has the Los Angeles Bureau of Power and Light. Other power companies are continuing the use of electric trucks and expanding their fleets as necessity arises. (See Figs. 5, 6 and 7.)

Value of Battery Charging Load

The value of the load offered central stations by the charging requirements of electric street and industrial trucks is almost too well known to need repetition. There is one phase of the matter, however, which requires attention. In many industries the trucks go to the garage between 5 and 6 o'clock in the evening and unless there is a particular advantage to be gained by not putting them on charge immediately, this will be done. The upper curve of Fig. 8 shows a typical summer load curve of the San Joaquin Light & Power Corporation, showing the battery charging load of its 7 trucks increased 500 times and directly superimposed on the load curve. It will be noted in this particular case that a small amount of battery charging load would not increase the evening peak above that of the morning peak. This condition will not hold for the majority of companies for which the evening peak determines the system peak capacity. The lower curve of the same figure shows the same battery charging load starting at 10 p.m. This shows how the battery charging load coming on at a later period fits into the valley of the load curve, meaning that it can be supplied without utilizing any peak capacity and at a time when light load on the system means very low line losses.

Operating Costs

The committee has continued to collect electric truck cost data as a basis for determining relative cost of operation of electric trucks and gasoline driven vehicles under comparable conditions.

There are a number of difficulties which have presented themselves in this work, such as the fact that many users do not keep cost records and of those that do so, it is difficult to find two who keep them in similar form so that comparative data can be obtained. Unless cost data is truly comparative, it may be very misleading. Thus, it would be obviously unfair to compare operating costs of **old** gasoline vehicles with those of **new** electric vehicles, and vice versa. Similarly, the cost of operating trucks in one city may not be comparable with that in another city, where conditions may vary considerably. The character of roads, hills and types of bodies used also affect costs. For this reason, it is not believed that the cost data that the committee has on hand is of very great value for making comparisons of cost on mileage or other unit basis. However, from this data, and from the experience of truck operators generally, certain approximate relations for estimating the comparative cost of gasoline and electric truck equipment under similar conditions has been deduced. This may be stated as follows:

1.—Repairs to chassis and body, including painting. The cost for the electric truck will vary from 25 per cent to 50 per cent of the cost for the gasoline truck, the lower value being used where routes have frequent starts and stops and severe hills to negotiate.

2—Tires. The cost of tires for an electric truck will approximate 60 per cent to 90 per cent of the cost of the gasoline truck.

3—Charging Current and Battery Renewals. The cost of charging current (based on an estimated cost of 2 cents per kw-hr.), plus battery renewals, will approximately equal the cost of gasoline and oil for gasoline trucks of same capacity on similar work, with gasoline at 20 cents per gal.

4—Servicing and Garage Expense. For fleets of comparable size and equally well serviced, the cost for electric and gasoline trucks will probably be about the same, but with a decided tendency favoring the electric.

5—Insurance, Licenses, Taxes, etc. Insurance is generally lower for the electric truck and electric truck garages. The present license rates are higher in California for electric trucks than for gasoline trucks, if gasoline tax is included in cost of fuel. The total for these items, including taxes, will probably be about the same in both cases.

6—Interest and Depreciation. Here, on account of the somewhat higher costs of electric trucks (including batteries) the item of interest will be higher than for the gasoline truck. The electric truck, however, will have a considerably longer economic life and the lower consequent depreciation rate will more than offset the higher interest charge. The interest and depreciation cost will average 10 per cent to 20 per cent less for the electric truck than for the gasoline truck.

7—Other Items. Such items of cost as investment in charging equipment for the electric truck will be offset by cost of shops and shop equipment parts, stock, etc., used in repairing the gasoline truck.

Assuming a percentage distribution of cost of gasoline truck operation as noted in Table V and applying the above ratios to the same we can arrive at an approximate relative cost for electric and gasoline truck fleets.

Table V—Comparative Cost of Gasoline and Electric Truck Operation

	Gasoline Trucks		Electric Trucks	
Item of Cost	Per Cent of Total	Ratio to Gasoline (%)		Per Cent of Gasoline Total
Repairs	23	25-50	5.75	11.50
Tires	7	60-90	4.20	6.30
Fuel or current and battery renewals	17	100	17.00	17.00
Servicing, etc.	7	100	7.00	7.00
Insurance	13	100	13.00	13.00
Interest and depreciation	33	80-90	26.40	29.70
	100		73.35	84.50

Thus, the cost of operation of electric trucks per unit of time or mileage on the same work will approximate from about 75 per cent to 85 per cent of the cost for gasoline vehicles of comparable size.

INDUSTRIAL TRUCK COMMITTEE

The electric industrial truck and tractor has enjoyed a great increase in use on the Pacific Coast, particularly in the last two or three years. The two chief reasons for this increased use are:

1—Freedom from competition.
2—Elimination of labor.

Generally speaking, the electric industrial truck is not in keen competition with gasoline trucks and tractors

Fig. 5—Fleet of electric trucks used by the San Joaquin Light & Power Corporation

or other types of mechanical devices for transporting materials in and around factories and warehouses. In most uses of this kind the danger from fire, the noise and the difficulty of successfully meeting requirements has prevented the use of gasoline trucks and tractors. The motor operated or gravity conveyor can be used in specific instances where material is continuously moved from a single definite point to another single and definite point. The use of conveyors is eliminated when flexibility of movement is required. For use around plants or in storage yards where roadways are either entirely lacking or are of very poor construction, the gasoline tractor is the electric's greatest competitor. The lumber and brick industries are good

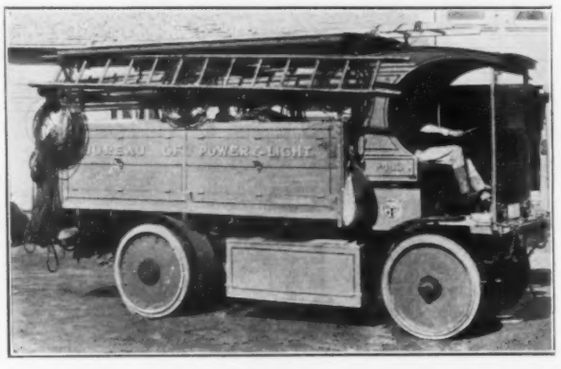


Fig. 6—One of the electrics used by the Los Angeles Bureau of Power and Light

examples of this type of use. Even in these industries, however, the electric is gaining in popularity, as is evinced by the fact that in California alone 26 trucks are used in the brick industry and 17 in the lumber industry. Of these, 8 have been placed in service during the six months ending Feb. 1, 1925.

The second reason for the increasing use of industrial trucks is due to the necessity in many organizations of reducing operating costs to a minimum in order to meet keen competition and to eliminate unnecessary expenditures for labor. It is this necessity which has been the reason for the introduction of practically all machinery. The use of labor saving devices for transporting materials short distances in and around industrial plants has not kept pace with other lines of machinery, and consequently still has a tremendous field open to it.

The industrial truck and tractor by eliminating labor, makes a definite showing on the payroll of the user and does not have to rely for its justification on saving in operating costs for the equipment itself, as is the

case of the electric street truck when compared to the gasoline truck.

Types In Use

The industrial truck and tractor is broadly divided into five groups:

1—Tractor
2—Truck.
3—Light truck.
4—Elevating or tiering truck.
5—Crane truck.

The tractor is used for hauling other trucks and has no space for carrying load itself. This type is used considerably in railroad terminals for handling express and baggage and in lumber mills for hauling wheeled platforms loaded with lumber.

The industrial truck with a load carrying platform is used to some extent for handling material which is loaded directly on to the truck and removed at the destination.

Fig. 7—Fleet of four new electric trucks just purchased by the Los Angeles Bureau of Power and Light

This type has been largely superseded by the lift truck which has a platform which can be raised or lowered several inches. Material to be moved is loaded on a small platform constructed in such a way that the lifting platform of the truck can be run under it and raised, lifting the material and its platform off the floor or ground. When the material has been carried to its destination, the process is reversed, leaving the material and its platform for unloading without tying up the electric truck. The use of many platforms enables the electric truck to be kept constantly on the move, which is very desirable.

A modification of the lift truck has been more recently developed with a platform which can be raised several feet. This type of truck is particularly convenient where material is to be stacked, as the transporting and the stacking operations may be performed by the single truck.

The industrial crane has also been developed in recent years to meet the demand for a small portable crane for handling materials which cannot be conveniently loaded on platforms.

Modification of these five types are in use for special purposes. The industrial truck because of its extreme simplicity can be designed for a great number of particular purposes with but very small additional cost.

Operating Costs

It is extremely difficult to secure operating costs and statistics as most of the concerns using these trucks either do not like to give out cost figures if they are kept, or do not bother to keep them. Many concerns, after investigation, are convinced that the use of electric trucks or tractors will reduce the labor required and will effect considerable saving. When these trucks are installed, the saving in payroll is immediately apparent, and consequently no further costs are kept.

Table VI shows a comparative test of unloading a vessel with electric trucks and with hand trucks. The electric truck shows a cost for labor of 10.4 per cent per ton moved, compared to 19.7 per cent per ton for labor with hand trucks. The saving of almost 50 per cent is indicative of the wide margin available for paying interest, depreciation and operating cost of the electric truck.

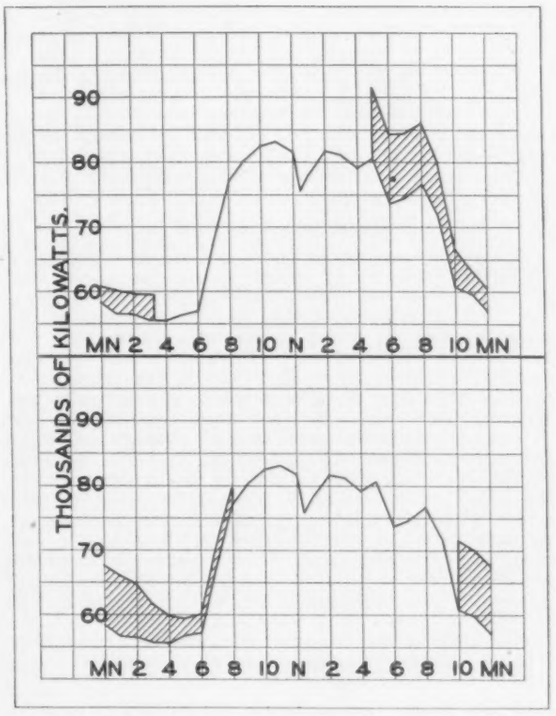


Fig. 8—Typical summer daily load curve of San Joaquin Light & Power Corporation with present charging load multiplied by 500 superimposed on present curve. Upper curve shows load coming on at 5 p.m. and lower with load coming on at 10 p.m.

Table VI—Cost of Unloading Eight Cars of Solid Freight from S. S. St. Louis Discharging at Savannah, Monday, June 9th, by Using Electric Trucks, Compared with Same Service Performed by Hand Trucks.

		Cost Per Ton
350	cases fuse—from ship to dock.....11 tons	
	3 motor truck drivers and 4 laborers ¾ hr.....$1.05	9½c
	By hand trucks 18 laborers ¾ hr..... 2.50	22¾c
224	cases and 25 bags coffee—to car.....13 tons	
	3 motor truck drivers and 8 laborers ½ hr.....$1.14	8c
	By hand trucks 20 laborers ½ hr..... 1.84	14c
300	bags fertilizer—to car.....15 tons	
	3 motor truck drivers and 8 laborers ¾ hr.....$1.71	11½c
	By hand trucks 20 laborers ¾ hr..... 2.76	18½c
260	bags and 22 barrels sulphur—to car.....16 tons	
	3 motor truck drivers and 8 laborers ½ hr.....$1.14	7.12c
	By hand trucks 20 laborers ½ hr..... 1.84	11½c
400	bags sugar—to car.....20 tons	
	3 motor truck drivers and 8 laborers ¾ hr.....$1.71	8.55c
	By hand trucks 25 laborers ¾ hr..... 3.44	17½c
225	bags flour—to dock.....11 tons	
	3 motor truck drivers and 8 laborers ½ hr.....$1.14	10½c
	By hand trucks 25 laborers ½ hr..... 2.30	21c
300	sacks rice—to dock.....15 tons	
	3 motor truck drivers and 8 laborers 1 hr.....$2.28	15½c
	By hand trucks 20 laborers 1 hr..... 3.68	24½c
463	rolls roofing paper—to car.....15 tons	
	3 motor truck drivers and 8 laborers ¾ hr.....$1.71	11½c
	By hand truck 20 laborers ¾ hr..... 2.76	18½c
Average cost of labor for electric trucks.....10.4c per ton		
Average cost of labor for hand trucks.....19.7c per ton		

Table VII shows a test made by the Matson Navigation Company of San Francisco. This company uses 47 industrial trucks and tractors which is proof positive of the saving in labor made possible by their use.

Table VII—Comparison of Cost of Freight Handling Between Electric Trucks and Hand Trucks on Matson Navigation Company's Dock.

Time Required	Number of Cases Moved	Distance Moved	Cars Loaded	Cost
11 Men with Hand Trucks				
1 hr. 55 min.	1,050	500 ft.	1	$13.20
9 Men with 1 Electric Truck				
1 hr. 10 min.	1,140	400 ft	1	$ 7.05

It may be well to mention at this point the extreme simplicity of the electric truck and tractor which makes possible its use by the same unskilled labor that is

commonly employed when hand trucks are used. This class of labor displays little care and skill in operating machinery, which means that electric industrial trucks are almost universally subjected to abuse. This is particularly true in steamship and stevedoring, lumber mills, brick and clay products industries, glass industry and metal manufacture and to a lesser extent in most other industries. It is only by reason of the extremely rugged and simple construction of the industrial truck that the characteristic efficiency of these devices is at all possible.

Battery Charging Load

The average industrial truck will consume from 10 to 12 kw-hr. per 8 hr. of operation and the tractor from 15 to 17 kw-hr. In a number of industries, the use of two sets of batteries makes possible the use of this equipment 24 hr. a day, which will practically triple the current consumption. In places where duplicate sets of batteries are used to enable the truck to be used 24 hr. a day, the charging load is practically continuous which makes it much more desirable because of its high load factor than the average industrial power application. The majority of users, however, employ the truck from 8 to 12 hr. a day, leaving only the night hours available for charging the battery. Under these circumstances, the same tremendous advantage that the electric street truck charging load offers in the development of off-peak power loads are present. The advantages the power companies will secure by the development of battery charging load have already been enumerated in connection with the electric street truck and their repetition here is needless.

Table VIII shows the total number of industrial trucks used in California segregated by industries.

Table VIII—Electric Industrial Trucks and Tractors In California Classified by Industries

Mar. 1, 1925

Automobile and tractor factories	18
Clay products	21
Fruit packers and sugar refineries	26
Grain and milling industries	14
Lumber industries	17
Manufacturers, jobbers, miscellaneous	67
Oil refineries	16
Shipyards	14
Steel and metal products	19
Terminal, freight, express, etc	162
Total in use Mar. 1, 1925	374

The detail list of the firms using industrial trucks and tractors and the number of these trucks which have been added during the six months ending Mar. 1, 1925, is shown in Table IX.

Table IX—California Users of Industrial Trucks

American Steel & Wire Company	4
Albers Bros. Milling Company, Oakland	2
American Can Company, Los Angeles	2
American Can Company, Oakland	3
American Can Company, San Jose	3
American Can Company, San Francisco	2
American Encaustic Tiling Company	2
American Railway Express	10
Associated Terminals Company	1
A. T. & S. F. Railroad Company, Los Angeles	4
A. T. & S. F. Railroad Company, Richmond	2
A. T. & S. F. Railroad Company, San Bernardino	10
Associated Oil Company	3
Bethlehem Shipbuilding Corporation, Ltd., Alameda	3
Bethlehem Shipbuilding Corporation, Ltd., San Francisco	11
Banning Company, The	1
Bay Cities Transportation Company	4
Best Tractor Company, C. L.	5
California Brick Company	1
California Hawaiian Sugar Company	5
Chevrolet Motor Car Company	2
California Associated Raisin Company	2
California Packing Corporation, San Francisco	1
California Packing Corporation, Sacramento	2
California Packing Corporation, Honolulu	1
Coast Tire & Rubber Company	1
California Wire Cloth Company	1
California Hawaiian Sugar Refining Company	5
City of Richmond, Harbor Department	2
Davidson Brick Company	4
Durant Motors Company of California	1
Edwards Company, E. H.	2
Fruit Growers Supply Company	2
Fuller & Company, W. P.	2
Gladding McBean & Company	7
General Electric Company, Oakland	1
Giant Powder Company	1
Graves Sash & Mill Company, Frank	1
Goodyear Tire & Rubber Company	1
Great Western Milling Company	1
Harbor Board, San Francisco	2
Harbor Board, Richmond	2
Hawaiian Pinapple Company, Ltd.	2
Holt Manufacturing Company	10
Hammond Lumber Company, Eureka	2
Hammond Lumber Company, Los Angeles	1
Hamburger Department Store, Los Angeles	1
Illinois Pacific Glass Company	2
Inter-Island Steam Navigation Company, Honolulu	2
Judson Manufacturing Company	3
Los Angeles Pressed Brick Company	3
Luckenbach Steamship Company	2
Los Angeles Drydock Company	3
Libby, McNeill & Libby, Sacramento	2
Matson Navigation Company, San Francisco	42
McCloud River Lumber Company	2
National Paper Products Company	5
National Lead Company	2
Oceanic Steamship Company	4
Oakland Mazda Lamp Division	1
Outer Harbor Dock & Ward Company	4
Pacific Steamship Company, San Francisco	14
Pacific Electric Company	2
Pacific Mail Steamship Company	4
Pacific Steamship Company, Los Angeles	11
Pacific Telephone & Telegraph Company, Los Angeles	1
Paraffine Paint Company	3
Parr Terminal Company	2
P-K Brick Company	3
Patton and Davis Lumber Company	1
Pioneer Paper Company	3
Pacific Bone Coal & Fertilizer Company	2
Pacific Guano & Fertilizer Company	3
Port Costa Warehouse Company	1
Pottenger Sanitorium, Los Angeles	1
Pullman Company	1
Pacific Gas and Electric Company, Emeryville	2
Pacific Clay Products Company, Los Angeles	3
Pacific Lumber Company	1
Rosenberg Bros.	3
Roscoe Moss Company	2
Richmond Pressed Brick Company	1
Sacramento Transportation Company	1
Schirmer Stevedoring Company	1
Simons Brick Company	3
Sugar Pine Lumber Company, Fresno	7
Sperry Flour Company	6
Standard Oil Company, El Segunda	3
Standard Oil Company, Richmond	10
Southern Pacific Company	6
Santa Monica Tram Company	8
State of California Department of Printing	1
U. S. Navy Bureau of Supplies and Accounts	2
Union Pacific Salt Company	1
Union Tool Company	2
United Studio	1
U. S. Army Air Station, North Island, San Diego	3
Union Terminal Warehouse Company	2
U. S. Army Transport Dock	6
U. S. Arsenal, Benicia	12
U. S. Navy Yard	12
U. S. Naval Air Station, North Island, San Diego	9
Western Sugar Refinery	1
	374

It is generally believed that there will be a greatly increasing use made of the industrial truck, as the Pacific Coast industries are constantly increasing in size and the necessity for keeping payrolls at a minimum is more widely appreciated. The electric utilities are beginning to appreciate the value of off-peak load and are cooperating with the truck distributors in a program of education which it is hoped will help place many more industrial trucks in use on the Coast.

APPENDIX

Executive Letters
No. 1.
April 8, 1925

Dear Sir:

We wired you April 6th as follows:

"Transportation Bureau of Pacific Coast Electrical Association after thorough investigation of electric trucks and tractors, urges your serious consideration of this desirable load as well as application in your own service. Please give personal attention to letters which follow."

In furnishing financial aid and in outlining the research work of this bureau, our understanding is that the executives of the member companies of the Pacific Coast Electrical Association wished an unbiased report on electric trucks and tractors as a medium for making a saving within their companies and opening a source of additional revenue. We have tried to cover this matter from its various angles and analyse not onnly the possibilities, but outline some of the difficulties in application.

We believe that executive action is necessary within the electric service companies to so systematize their transportation that the savings possible by the use of electric trucks may become an actuality. The use of electric trucks is of great importance as an example in encouraging the buying public to make proper and economical installations of transportation units.

We have prepared information showing the net profits accruing to electric service companies through the use of electric trucks and the revenue from the battery charging load. This will be sent to you shortly.

Yours very truly,

Chairman Transportation Bureau
Pacific Coast Electrical Association.

No. 2

April 13, 1925

Dear Sir:

You, as an executive, are interested in the net profit your company would earn by sponsoring electric trucks.

Among the advantages you would gain under such a program are the following:

1—Increased revenue—one electric truck will use as many kilowatt hours per year as twenty average residences.

2—Economy—and therefore greater profits—of servicing one customer as against twenty or more.

3—Diversity—the battery charging load is usually off-peak and will not require additional generating transmission and substation facilities.

4—Popularizing of electricity—every electric truck advertises electricity.

5—Advocating lower delivery costs is in keeping with your leadership in community and business affairs.

6—Using electric trucks on your frequent-stop jobs will set a good example and will cut your operating cost, placing your transportation department on the most economical basis.

Please give these thoughts your careful consideration.

Yours very truly,

Chairman Transportation Bureau
Pacific Coast Electrical Association.

No. 3

April 16, 1925

Dear Sir:

In our previous letter, we told you that the use of electric trucks by your company would not only be a good example, but would also cut your transportation costs in your city work.

The consensus of opinion among scores of industrial and business executives interviewed is that 75 per cent of all local delivery and short-haul routes can be more efficiently and more profitably handled by electric trucks.

Why not ask the head of your transportation department for a report giving definite reasons for not using electric trucks? We are supplying him with data on their application and stand ready to assist in any further studies you wish to make of your particular situation.

Yours very truly,

Chairman Transportation Bureau
Pacific Coast Electrical Association.

No. 4

April 20, 1925

Dear Sir:

The potential market for electric trucks existing in your community will surprise you. Using the recognized premise, as outlined in our letter of April 16th, 75 per cent of all local delivery, short-haul routes can be more efficiently and more profitably handled by electric trucks than either gasoline trucks or horse-drawn vehicles.

What would it mean to you if this potential field were saturated? 6,000 to 10,000 kw-hr. annually in current consumption will be realized from each electric truck in service. Figure how this would fill up the valley of your present load curve.

Yours very truly,

Chairman Transportation Bureau
Pacific Coast Electrical Association.

No. 5

April 23, 1925

Dear Sir:

Detail investigations of current consumed by the average electric truck show that annually it consumes the amount of current which would be required to operate the following number of appliances:

280 vacuum cleaners, or 760 warming pads, or 500 sewing machines, or 550 fans, or 310 washing machines, or 225 toasters.

Is this not convincing proof of the profit to be derived from servicing a single electric truck against a group of these other appliances. You know how much money has been spent on campaigns to increase the use of household appliances. Are you overlooking the profit to be derived from the super-appliance—the electric truck?

Yours very truly,

Chairman Transportation Bureau
Pacific Coast Electrical Association.

No. 6

April 27, 1925

Dear Sir:

Our records show that of the 556 electric street trucks in the state, 104 are being charged from the lines of your company. This does not include industrial trucks in the state. Each of these trucks uses from 6,000 to 10,000 kw-hr. annually, probably twenty times that used by the average residential lighting consumer. Much of the residential lighting use comes during peak hours and ties up capital in generating, transmitting, and substation facilities. The electric truck load is, or can easily be made, off peak. This load, as soon as the cost of servicing is repaid, can be supplied from off-peak hydro at no cost, or from existing steam plants for the cost of fuel and maintenance only.

The Pacific Gas and Electric Company are supplying power for charging the fleet of thirteen electric trucks recently placed in the city of Oakland by the American Railway Express Company. The cost of service to this installation of $1,440 will be entirely recovered in 7½ months' operation. As soon as the entire fleet or 25 trucks now planned is in operation, the estimated monthly revenue for this off-peak power will be $334.

Yours very truly,

Chairman Transportation Bureau
Pacific Coast Electrical Association.

No. 7

April 30, 1925

Dear Sir:

After assuring yourself that the net profits of your company are yielding a fair return upon the invested capital, your next concern is rendering the consumer the best possible service at the lowest possible cost. The more nearly you are able to fit the demand for power to the potential output of your generating plants, the more nearly will your generators and lines be continuously loaded and the lower will it be possible to make the rates for all kinds of electric service.

You are attempting to fit your seasonal power demand to your potential power resources by the development of seasonal load, such as winter irrigation. Your daily load factor will be improved by filling up each night's valley. The charging load of electric trucks and tractors will fill this valley better than any other known load.

Yours very truly,

Chairman Transportation Bureau
Pacific Coast Electrical Association.

No. 8

May 4, 1925

Dear Sir:

A baker would say, "The proof of the pudding is in the eating." Electric utility executives would probably paraphrase this to read: "The proof of an appliance is in the using." The following list shows the electric trucks and tractors which are in use in California today:

Electric Street Trucks		Electric Industrial Truck and Tractors	
Ice Cream	28	Automobile and tractor factories	18
Creameries and dairies	200	Clay products	21
Laundries	35	Fruit packers and sugar refineries	26
Ice companies	28	Grain and milling industries	14
Baking companies	129	Lumber industries	17
Express companies	20	Manufacturers, jobbers, miscellaneous	67
Department stores	34	Oil refineries	16
Mercantile stores	14	Shipyards	14
Public utilities	42	Steel and metal products	19
Soft drink mfg.	9	Terminal, freight, expres., etc.	162
Grain and milling	4		
Municipalities	4		
Miscellaneous	9		
Total in use Mar. 1, 1925	556	Total in use Mar. 1, 1025	374

All reports indicate increasing interest in the economies effected by electric trucks and tractors. When you realize that each of these 930 units consumes from 6,000 to 10,000 kw-hr. of off-peak power, the net profit thus derived is seen to be surprisingly large.

Yours very truly,

Chairman Transportation Bureau
Pacific Coast Electrical Association.

No. 9

May 7, 1925

Dear Sir:

When distances are to be covered within a radius of 30 to 35 miles, particularly in city work where stops are frequent because of traffic conditions, the speed factor of the gasoline truck loses its value and instead becomes inefficient and costly. The many stops cut down the high maximum speed to a comparatively low average speed, while gasoline consumption is increased with each stop and start.

Statistics from tests made by the Post Master General"s office show that where there is frequent starting and stopping, the gasoline consumption is three or four times as great as on long hauls with few stops. For just such uses where costs increase in gasoline truck operation, the electric truck is the logical delivery unit to use. Its characteristics are just a reverse of those of the gasoline truck. Its ease of handling and rapid acceleration makes a high average speed possible through congested traffic or when making many stops. The motor does not idle when the truck is standing nor is there a clutch and transmission to receive severe trials at each start.

Yours very truly,

Chairman Transportation Bureau
Pacific Coast Electrical Association.

No. 10

May 11, 1925

Dear Sir:

You have perhaps wondered just what was the attitude of the American Railway Express Company, known throughout the country as the largest user of truck equipment and a most discriminating buyer. This company's attitude is expressed in the following statement by Mr. E. E. La Schum, who is general superintendent in charge of motor equipment: "From our experience and observation, we are firmly convinced that in its particuuar field, the electric truck is the most economical, reliable and efficient vehicle in operation today."

Mr. Robert E. M. Cowie, president of the same company, has stated: "The advantages secured by the use of electric trucks on short haul or frequent stop routes may be briefly recapitulated as follows, and these, gentlemen, are the main reasons why the American Railway Express Company is today using 1,800 electric vehicles:

1—Electric trucks greatly reduce costs.

2—They are the fastest trucks there are on short haul or frequent stop routes.

3—The electric's simplicity makes it easy to run and easy to repair.

4—It is rugged and reliable, seldom breaking down on the road and becoming disabled less frequently than any other type of vehicle.

5—Electric trucks last a good deal longer than gas trucks.
6—The electric truck is clean, insuring immaculate and sanitary conditions for the goods it conveys.
7—The electric truck is quiet.
8—The electric truck is odorless.
9—It can be stored at loading platform, saving garage space.
10—It uses power with the minimum of waste.
11—It has all the speed that is consistent with prudence in city running and power economy.
12—Employee's control of the speed is inherent in the truck.
13—Its tractive power is greatest in proportion to the horsepower used.
14—Its hazard of fire, accidents and theft is lowest.
15—Its cost is less to run and maintain.

Those are the specific reasons for our selection of 1,800 electric vehicle—and those fifteen points which I have enumerated are certainly worthy of the consideration of every intelligent executive in business."

Should not the statements of executives of a concern, whose sole business is transportation, be conclusive evidence?

Yours very truly,
Chairman Transportation Bureau
Pacific Coast Electrical Association.

No. 11

May 18, 1925

Dear Sir:

The Pacific Gas and Electric Company is thoroughly cognizant of the economies which can be effected in its own transportation department by the use of electric trucks and the net profit to be secured in promoting the use of electric trucks and tractors. This company has eight electric trucks in its fleet and two years ago organized an Electric Truck Promotional Bureau.

Mr. F. A. Leach, the general manager, in a talk before the Commercial Section of the National Electric Light Association, said in part: "I have been a thorough believer in the electric truck and the electric vehicle. I was among the early purchasers of electric trucks and when I was manager of the company's properties in Alameda County, I ran a fleet of eight or ten trucks, electric trucks, and at that time I think we had only two gas driven vehicles. But we must not be discouraged with the present apathy toward the electric vehicle. It is the coming motive power for city transportation, and there is a great outlet there for energy, which would otherwise go to waste, particularly when we have hydro electric development."

If the executives of every electric utility in California were to take the same attitude, most of the apathy Mr. Leach refers to would be overcome and a good start made in getting electric trucks used in 75 per cent of all local delivery and short hauls. This figure has been set by experts after thorough investigation as the quota for city delivery work which can be most economically handled by the electric vehicle.

Yours very truly,
Chairman Transportation Bureau
Pacific Coast Electrical Association.

No. 12

May 25, 1925

Dear Sir:

You have been receiving "facts" in the past few weeks with reference to the electric truck as a possible revenue producer for your company.

The question now in your mind, "How can my company best organize to promote the sale of electric trucks?" This question can perhaps be answered best by giving you the method adopted by central stations promoting the electric truck and tractor. This has been done by the formation of an electric truck promotional bureau in the larger cities and by the assignment of a particular salesman to devote all or part of his time to this work in the smaller centers.

In adopting this method, you are following in the path of proven experience and success should attend your efforts in this direction. Our next letter will detail some of the functions of this bureau or individual salesman.

Yours very truly,
Chairman Transportation Bureau
Pacific Coast Electrical Association.

No. 13

June 1, 1925

Dear Sir:

In our previous letter we suggested that you organize an electric truck promotional bureau, or have an individual salesman assigned this work. There are several points that should be given careful consideration in the adoption of such a program.

1—Persons selected by your company for this work should not be in any sense classified or referred to as an electric truck salesman. His attitude must in all instances be non-partisan, remembering that every electric truck, battery and accessory in general manufacture is a good one—they all save money.

2—The collection and compilation of data regarding the comparative cost of operation of horse drawn, gasoline and electric trucks will be especially beneficial to your business community. This presupposes, of course, that the person delegated for this work will spend sufficient time to acquaint himself with the subject of commercial haulage and delivery work, with special reference to the application of electric trucks. It is highly essential that he learn the methods used by electric truck salesmen in overcoming gasoline truck and horse-drawn competition on what are obviously electric truck routes.

3—A complete file of the names of all electric truck owners in your territory should be maintained, together with a list of prospective purchasers and users of trucks of any sort. The list of trucks registered may be obtained from the Secretary of State from which list may be selected and listed on cards the electric vehicle owners.

4—A standing invitation should be extended at all times for local business firms in your community to consult or use the service of this bureau to find out in a nonpartisan way the relative merits of different types of delivery equipment.

5—The person selected should work in close harmony with any electric transportation association which may be in existence in your community or should work toward the establishment of such an association in order to bring the distributors and users of electric trucks, tractors and batteries into closer cooperation.

The Transportation Bureau has arranged to hold an electric vehicle school in San Francisco, June 8-13, which is the week just preceding the National Electric Light Association convention. You have already been advised of this school and asked to send one or more representatives from your sales and transportation departments. If you have not already given this matter your attention, registration should be made immediately through the chairman of the bureau. The bureau, as always, stands ready to assist in any matters pertaining to the use of transportation units.

Yours very truly,
Chairman Transportation Bureau
Pacific Coast Electrical Association.

First Aid Training

By CHAS. E. MORDOFF, M.D.*

ACCIDENT and fatality rates in industry in the United States are the highest in the world, and we all believe and in some places it has been proved that these rates are far higher than they need be. When we read that large industries have records of three months, six months, a year, and in one large company four years, with no lost time accidents we must believe that these records can be reproduced in our own industry.

It is probably conservative to state that 90 per cent of all accidents are preventable; that they are the result of thoughtlessness or of some state of mind which attracts the attention away from the job in hand.

The old method of accident prevention by using a list of "don'ts" has never been a success and has, of necessity, been replaced by more modern usages. There are many ways by which accident prevention propaganda can be put over, but whatever method is employed, success in reaching a goal must depend upon safe construction and maintenance of equipment, safe working methods, convincing the workmen of the value of foresight, good coaching and team work.

Of these, team work is certainly not the least in importance and, to my mind, there is no better way by which team work may be obtained than through instruction in first aid methods and by the development of first aid teams. First aid training, not of a selected few but of every individual in the force, cannot help but increase the efficiency of the force. Competitive first aid teams increase interest in this training and develop a team work which inevitably tends toward a higher morale. The spirit of competition rules here as it does elsewhere, in college for instance, and a department or district will take an interest in and encourage its first aid team against those from other departments or districts.

The matter of when instruction may be given, whether on company time or on the employee's time, depends to a large extent on individual company conditions. Who shall train the first aid classes among employees of an industrial plant? In many large industries and in many large cities, instructors accredited by the American Red Cross or by the U. S. Bureau of Mines are holding classes for the first aid training of industrial workers. In a majority of cases these instructors are the company physicians and their assistants who are qualified to instruct in the use of the triangular bandage. This type of bandage is the standard of the Bureau of Mines, and is used by teams in competitive work.

In teaching industrial first aid it is important that a minimum standard of instruction be adopted and that the training be general and not confined to the treatment of the types of accidents which are most likely to occur in a particular industry.

Any plan for first aid training should be built about four cardinal points, viz:

1. Shock—its symptoms and treatment.
2. Hemorrhage—how to control by direct pressure, seldom by tourniquet.
3. Asphyxia—its causes, symptoms and treatment; artificial respiration by the Schaefer prone pressure method; and the Sylvester method.
4. Transportation—careful handling of the injured in a minimum of time, so as not to cause pain or further trauma.

* Report of Accident Prevention Bureau, Technical Section.

First aid is not intended to take the place of medical service but serves rather to fill in the gap between the accident and the arrival of the physician. This is the period when minutes may mean the difference between life and death and when skillful treatment by a trained layman may save a life. The trained man knows what to do and he does it while his fellow workers are debating what should be done and suggesting all manner of crude remedies.

While the teaching of first aid methods to be of the utmost value should include training under the four heads outlined above, the first essential is simplicity The use of complicated anatomical charts and preponderant medical terms is often puzzling to the majority of the class being trained. It is far better to teach by demonstrations and actual practice by the class and to minimize the amount of lecturing used. To know what to do in an emergency is really the important thing. The man who can put his thumb on an artery spurting blood and hold it there until someone else can summon a physician will often save a life.

Almost of equal importance is the knowledge of what not to do. For instance, an onlooker thinking to be of assistance to a man who may have fallen from a scaffold runs to him and hoists him to his feet, thereby converting a simple fracture into a compound one.

By far the most important first aid work in the electrical industry, both in construction, generating and transmitting, is resuscitation from shock. The Accident Prevention Committee of the National Electric Light Association has adopted the standard method of artificial respiration known as the Schaefer or prone pressure method. There can be no argument against this selection, when performed according to the technique which has been worked out by the U. S. Bureau of Mines in cooperation with the American Red Cross. This method has also been indorsed by the United States Public Health Service and the National Safety Council.

While first aid is really separate and distinct from accident prevention, it has unquestionable value as an adjunct thereto, and should be included as an intimate part of every accident prevention program.

In order to determine what is being done by the Coast companies in the way of first aid training of their employees, the following companies were sent questionnaires:

Great Western Power Company.
Southern California Edison Company.
San Diego Consolidated Gas & Electric Company.
Coast Counties Gas & Electric Company.
Bureau of Power and Light, Los Angeles.
Southern Sierras Power Company.
California Oregon Power Company.
Pacific Gas and Electric Company.

The replies indicate that the Pacific Gas and Electric Company is giving the most complete training in first aid of any of the member organizations. While the first aid training work of that company is temporarily discontinued, the first aid trainer has been retained and it is expected that the work will be continued again during 1925. All of the other companies have given some training in resuscitation but for the most part very little training in other lines of first aid. This work has been done very largely by demonstratioins and in company time.

The Pacific Gas and Electric Company and the San Joaquin Light & Power Corporation, the latter not so extensively as the former, have carried on general instruction in first aid training and the employees of these companies have received the course given by the U. S. Bureau of Mines. In these two companies the work was carried on within the organization by trained laymen, supplemented in the latter company by occasional lectures and demonstrations by the medical director.

In the Southern California Edison Company and the Bureau of Power and Light of Los Angeles, the training is given by the safety engineer. In the other organizations it has been given by operating superintendents and their assistants.

In most companies the training in resuscitation is compulsory because it is given in company time, but the men are not disciplined if they do not attend every lecture. In some companies the work has been done partially in company time and partially in the man's time, while in one company the Bureau of Mines course was given in company time and the follow-up course in the man's time.

The Pacific Gas and Electric Company is the only member organization on the Coast which has consistently held intra-company first aid contests, although no team from that organization competed in the 1924 State First Aid Meet. It is expected that this work will be continued in 1925 and a team entered in the contests of that year. The San Joaquin Light & Power Corporation entered a team in the state meet but has made no definite arrangement for intra-company contests, nor for prizes for such contests. None of the other member organizations have organized any first aid teams or contests although several have expressed a hope that their first aid training program would be such that first aid teams would be developed and trained during 1925.

In the San Joaquin Light & Power Corporation and its subsidiary companies, the Midland Counties Public Service Corporation, Fresno City Water Company and the Bakersfield and Kern Railway, first aid training is being given to every employee. An instructor, who is trained by the U. S. Bureau of Mines, is combining first aid instruction with accident prevention directly, in that he is making inspection under the Railroad Commission G.O. 64 which is, in every essential, a safety order.

This trainer reports directly to the general superintendent of operation, but also reports to the Central Accident Prevention Committee and is a member of that committee forming an essential point of human contact between it and the local committees.

The plan which is being followed is that this instructor will train two or three men in each district or department, giving them intensive instruction, with the view of making them instructors and with the expectation that they will give instruction to every employee within their district or department.

All of the companies believe that the first aid work does result in real preparedness for the emergency treatment of injuries, also, that its benefits do reach into the home, and that the knowledge of emergency treatment methods has prevented many serious consequences from simple injuries.

The consensus of opinion seems to be that the U. S. Bureau of Mines standard training methods are best and several of them have stated that they hope to be able to have a team entered from their company in the 1925 state meet.

There can be no effective argument against the first aid training idea. That it is a good thing is admitted by everyone and experience has taught that as a part of an accident prevention campaign first aid training is highly effective. It is my opinion that first aid training in general can best be given by a thoroughly trained layman, who is able to get the average employee's viewpoint, and that it should be compulsory for all employees and the work be given in company time.

First aid instruction, and particularly instruction in methods of resuscitation from shock, form an excellent medium for the enhancement of better public relations. This is especially true in rural districts and has been forcibly brought to mind during the past year by a number of electric shock accidents to rural consumers, the lives of some of whom might have been saved, had their neighbors known how to give artificial respiration.

The broadcasting of knowledge of first aid methods, by whatever means it may be done, is worth any effort which it may cost. It would be a wonderful thing if every person in the entire territory served by the member companies of this association could be instructed in methods of first aid to the injured or at least in artificial respiration and the control of hemorrhage. Good work along this line might be accomplished in all of the companies, by offering to instruct farm bureaus, Boy Scout troops, high school cadets and civic bodies.

Whether or not a first aid team is desirable is a matter for each individual organization to determine, but I believe there can be no question as to its value not only to the team which receives the intensive training necessary to prepare it for contest work, but also to the entire organization because of the interest which it stimulates among the employee personnel. In order to stimulate the interest of first aid teams, inter-department or inter-district contests seem to be desirable and prizes of some sort may be offered.

Experience has shown that the attitude of the foreman toward this work is very greatly reflected in the attitude of the men under him. It should be the first job of the first aid instructor to sell the foreman the idea of the value of first aid, and it should be the duty of the management to see that every foreman is not only a competent first aid man himself, but that he shall be interested in the teaching of first aid methods to his men.

If no trained layman is available for the teaching of first aid in any of the member organizations and it is possible to obtain the services of the U. S. Bureau of Mines, it is highly desirable that every employee receive at least that training, which requires five days, two hours per day. This course gives the ground work for complete first aid instruction which may then be followed by a lay instructor or by trained superintendents or their assistants.

The Pacific Gas and Electric Company approaches the ideal in first aid instruction by having a full time instructor whose business it is to continually visit the various districts and teach all employees in those districts.

Company Organizations for Accident Prevention

By E. J. KENDALL*

FOR the purpose of ascertaining how and to what extent various corporations endeavor to prevent accidents in connection with their work, a questionnaire was mailed to and replies have been received from, eight Pacific Coast electric light and power corporations. Very full and specific information has been furnished by some companies, while others have submitted a rather brief and quite general report.

It is felt that the following will, to some extent, give the desired information as to the above subject:

In one case, we find that the organization for accident prevention consists of a central accident prevention committee composed of a general inspector, as chairman, and members of the medical, operating, transportation, construction and personnel departments. This committee holds monthly meetings and considers reports received from their local committees. Strictly speaking, there is no safety department, although the general inspection department acts in that capacity.

One company has a general safety committee consisting of three division engineers and the secretary of the electrical engineer, who meet approximately once a month, or oftener if necessary.

In still another case is a body known as the central committee composed of four representatives from various departments, who are interested in matters pertaining to inspection. This committee also acts in an advisorial way. They have positive control over accident prevention and training activities, which work is directly handled, in a general way, by the traveling superintendent. Regular meetings are held at which reports of current accidents are reviewed and preventative measures formulated.

Another company has a general central safety committee composed of various officers of the corporation who have general charge and supervision of safety work over their division safety committees. They establish safeguard standards and promulgate safety rules, as well as passing on or controverting safety matters and consider the awarding of prizes to individuals and departments for the best suggestions and records made for safety, as well as selectiing and designating premium stations or districts. In two of the above mentioned companies the accident prevention work is carried on under the direction of the claims department.

The central and general safety committees of the various companies mentioned above are, in numerous instances, supplemented by local accident prevention committees located in each district, power house, garage or machine shop. Meetings are held at a date just prior to the meetings set for the central or general committees, to which the reports of the local committees are sent for consideration. There are also local safety committees composed of foremen only, who hold meetings in their respective divisions. In some of the larger corporations there is a division safety committee in each division. These committees consist of a superintendent, a foreman, and one workman serving for a period of three months each. As each member retires his place is filled by a new man elected by the remainder of the members of the committee or appointed by the division manager to serve for three months; thus one member of this committee retires each month. In the division committee just mentioned each member acts as chairman for the last month of his term, thus always making the chairman the oldest member; and as a badge of distinction, each member of the safety committee wears a safety button furnished by the company, which he passes on to his successor upon retirement.

The duties of the division safety committee are to make safety inspections in its respective division, recommending safeguards, rules for safety, and safe working methods. They also investigate serious accidents and render written reports on forms provided for that purpose to their central or general safety committee. Each division safety committee submits a report of the result of their monthly inspections to the secretary of the central, or general safety committee. These reports are carefully preserved and copies are sent to the heads of the operating departments, and when the safety engineer inspects each division, he checks the division safety committee's reports.

The central safety committee issues safety bulletins twice a month dealing with accidents which have occurred on the system, at the same time showing the conditions found at different points. These bulletins are sent out regularly to each station, substation, warehouse, office, etc., where they are posted in conspicuous places.

Many, if not all of the local safety committees act in an advisory capacity only, reporting either to a safety engineer, inspector, superintendent or general or central safety committee.

Few, if any of the corporations have a full time "Safety Officer," although the Bureau of Power and Light of Los Angeles has a general safety committee, which includes the safety engineer who sees that all of the proper methods for accident prevention are carried out, also that the first aid work and first aid training are duly executed.

Another standing safety committee is composed of five types of employees, selected for their intellignce. This committee comprises men of or below the rank of foreman, and it is their duty to inspect, constructively criticise and recommend remedial measures. On this committee there is an employment or first aid officer, who acts as secretary of the committee. He sends a copy of his reports to the general superintendent and to each department head and theirs is the responsibility for remedial action. The prestige of this committee is, naturally, maintained by the type of men chosen for such important work.

Another form of committee, not mentioned in the foregoing, is in the case of a corporation having no central or local committees, all accident matters being handled directly by the claims department, who receive three different reports, one being signed by the employee in charge of the work in connection with which the accident has happened; a report signed by the injured and also reports of the witnesses to the accident. These reports are made in triplicate and are distributed, through the claims department, to the general superintendent, division superintendent and paymaster. The latter uses his copy for checking payrolls in cases where men are transferred from the regular to a compensation payroll. A so-called committee in this company automatically forms as soon as an accident occurs, consisting of the general superintendent, claims agent, division superintendent and district foreman. If the accident is caused by some condition of hazard, such condition is certain to be definitely disclosed and remedied as a result of this method. The accident prevention and educational work is left in this corporation with the various operating superintendents or heads.

Regarding the attitude of workers and foremen towards the organizations for prevention of accidents, various results have been found and expressed by such opinions as "fair and improving," "generally good," "fair," "quite satisfactory," "very unfavorable," "interest manifested and great improvement shown in different classes of work" and "interested and friendly." It also appears that the interest shown and regard taken for accident prevention work is proportionate to a

* Report of Accident Prevention Bureau, Technical Section.

man's earning capacity and intellectual rating. The lower one gets in this scale of classification, the less the interest shown, generally speaking. It is found that the attitude of workers and foremen towards the organizations has been very good, and the cooperation of local committees in the districts with the central or general committee, has been quite satisfactory. Occasionally, however, some resentment is shown by the individual. Again it is found that large majorities of the employees and the foremen show a considerable degree of confidence in the method and results of accident prevention work. It is even said that this is true with foremen and workmen, who more readily accept these methods than do those men higher up, such as district managers, local superintendents and agents.

In connection with the method of operation and extent of accepted or acknowledged authority, it appears in one instance where the general manager has plainly indicated his own backing of his safety organization and its work. This known approval of the general manager has been reflected down the line by a respect for the same on the part of the department heads and foremen. Also, the work, after having been accomplished, has gained greater respect and standing among the men. In a few individual cases it was found necessary to get word direct from the general manager to an "unbeliever," but these have been very few and have had their effect. Persistency in this work is of the greatest value. Where periodical inspections are made of plants and equipment by capable employees, and due consideration of reports of such inspection by the proper committee is given and steps taken to remedy unsafe conditions, it is found that all of these things are considered by the employees, generally, as desirable and helpful to all concerned. It is also good practice, where equipment and personal property or tools of the employee are found to be unsafe, that said equipment or tools should be condemned and employees instructed to secure safer ones. In most instances where corrective measures are recommended after inspection by local safety committees, all action is left to the management.

In those instances where a safety engineer is employed, he is usually and almost without exception, considered and called into consultation with any group who are studying the questions where safety is considered and his experience and opinion are deferred to.

The effectiveness or practical results of these forms of organizations appear to be as follows:

Satisfactory results have been accomplished in a rather quiet, and it is believed, a more effective way than could be done by a safety supervisor or inspector making it his whole business, unless perhaps it were possible to find just exactly the right man, which is difficult. It must be admitted that the man whose knowledge of safety work and, at the same time, of the company's business in its various departments, with the right personality and peculiar characteristics essentially necessary, is hard to find.

It would seem very advisable that full authority be vested in the central or general committee and that the various department heads let it be well known that the general manager has given definite authority for carrying on of the accident prevention work of the committee. It has been found that when this has been properly done the men themselvs become quite interested in this work. Most of the replies to our questionnaire would indicate that the forms of organizations, as above outlined, are satisfactory, effective and produce at least good, practical results.

The extent and manner or method of the work of accident prevention is dependent, in great measure, upon the size and activity of the particular organization in question. This line of endeavor is different from general welfare or insurance work. and in order to secure the best results, should be handled by a man or a group of men thoroughly familiar with the equipment and operating practice of the company; by a man or men holding the confidence of the general body of employees and by those thoroughly enthusiastic in the work of accident prevention. Committee reports and reports of proceedings and findings should be given considerable publicity, and commendation should follow safe action and suggestions, as well as censure for carelessness or lack of thought or observation. It might be very advisable to make the minutes of the central or general committees available to the district or local committees for their general information.

It is suggested that complete records of all accidents should be kept. These records should be classified and subdivided to such an extent that a comparative compilation may be readily made and from which can be shown benefits resulting from accident prevention efforts. In this, and in no other way can those who are deeply interested in the subject of accident prevention show that their work has been worth while and that they have not only accomplished the much desired result of preventing accidents, but that they have, as well, effected a considerable monetary saving. Other methods suggested for stimulating interest and cooperation as mentioned in the various replies to our questionnaire are competition between crews, districts or departments, decisions being based on percentage, handicaps, etc., rather than upon actual records. Also, that after a satisfactory basis for competition could be decided upon, competition between companies might be a wonderful stimulant towards making a complete organization a central accident prevention committee.

Among the suggestions made of various methods used for stimulating the activity of individuals and committees, one company considers it advisable to make the accident prevention phase a part of the regular work of employees.

One of our correspondents very happily states that they did not find it necessary to stimulate safety activity for the reason that loyalty to the company and each other is very pronounced among the men of that company. Furthermore, it has been found that by giving all credit to the committees for suggestions and accomplishment of a reduction in accident frequency and severity, their activity will thereby be stimulated and kept alive. Also the giving to individuals and committees of some idea of the frequency and severity of accidents in their particular district as compared with some other district or districts has a tendency to cause a friendly rivalry between districts in making a showing of a "No Accident Record." It has also been found that where some problem exists good results follow by giving to the local committee or some member of such committee, the opportunity to suggest some remedy or to study and make a report on the existing condition, rather than to have an inspector embody the same in his report as against the local committee or member.

Finally, there appears to be little question that the effectiveness of accident prevention campaigns through various committees or other channels has been shown.

Apparently one of the best forms of organizations might be considered as that of a central accident prevention committee composed of representatives from various departments of the company, working closely with local committees. The central committee is more or less permanent in organization, while the local committee is usually composed of only a few members whose services as such end within a few months, leaving, however, one old member on the committee. This permits a considerable number of employees in each locality to come into close contact with accident prevention work.

The scope or limit of authority given to the general committee necessarily must not be too great because the ultimate decision in many things, especially where the expenditure of money or question of policy is involved, must rest with the management. It is well to make the scope of activity as great as the committee can make it without overstepping the bounds of pure accident prevention or health conservation.

Regarding the use of bulletins, one of our correspondents is of the opinion that bulletins have more of an interest to the average employee than written or printed advice. for the reason that pictures will better attract and hold his attention. If these bulletins can be made up covering recent local accidents and injuries, they will interest men even more than the stock safety bulletins, illustrating possible accidents. This same correspondent also believes that safety suggestion boxes are a good thing, and that from time to time good suggestions, which might well be adopted, could be had from such boxes. Safety films to be had both from the national safety council and from the State Industrial Accident Commission also have their proper place and effect.

Without doubt, much good can be accomplished through frequent personal contacts with local accident prevention committees by a member or members from the central accident prevention committee. The local committee's interest would most likely be much stimulated thereby. No such effort is ever wasted.

Safety Bulletins

By F. V. WRIGHT*

THE accident prevention work of practically all member companies includes, to some extent, the use of safety bulletins. For purpose of consideration the extent of use will be divided and discussed as follows:

Intensive

Seven of the nine companies reporting use the bulletin service of the National Safety Council for their primary requirements. Bulletins which carry a pertinent message of caution or safe practice are selected and posted on bulletin boards (either special or general) located in positions most convenient for observation by employees entering or leaving work. A few of the companies supplement the National Safety Council bulletins by some which they prepare themselves or obtain from insurance companies.

Casual

The Pacific Gas and Electric Company uses only bulletins prepared in its own organization. A new bulletin is published twice a month usually depicting one of its own accidents or showing accident statistics.

The California Oregon Power Company has permanently posted its system with the N.E.L.A. bulletin on the Schaefer method of resuscitation but makes only occasional use of other bulletins.

The methods of circulating and posting are varied. All agree that bulletin boards should be provided in prominent locations and be protected from the weather. Quite elaborate boards are provided by some companies. The opinion is general that only one bulletin, or at most not to exceed three or four, should be posted at a time and these changed frequently, whether on a special or general bulletin board.

The apparent effectiveness as well as the attitude of the employee depends upon the attitude of the company and the accident prevention committee. When intensive use is made and posting and circulating closely supervised, the apparent value is reported as highly satisfactory. When the safety supervisors are careless in selecting and posting and consider the bulletins of little value the attitude of the employee reflects this condition.

Suggestions

It has been demonstrated generally that bulletins properly selected with subjects covering the everyday hazards, careless practices and simple safeguards with very little printed matter, are a very important part of an accident prevention program.

To secure proper consideration by the employee, bulletins should be treated with respect by the safety engineer, foreman, superintendent and committeemen, kept in good condition until posted and posted in such location as to secure the voluntary attention of the employees and protected against mutilation. In other words, the safety engineer, committeemen, foremen and superintendents must be sold on the value of the safety bulletin before we can expect serious consideration by the employee.

A uniform procedure for the use of safety bulletins cannot be recommended for all companies in the absence of more or less uniform methods along all lines of accident prevention work. Special conditions and emergencies must be met from time to time with special treatment. Bulletins, to a certain extent, follow the accident prevention program and the adoption of standard methods would to some extent restrict the individual initiative.

The exchange by member companies, through this committee, of plans and special bulletins which have proved of more than usual value should be continued on an extended scale during the next year to secure the greatest value in educational work of accident prevention.

* Report of Accident Prevention Bureau, Technical Section.

Code of Safety Rules and Safe Practices

By V. R. HUGHES*

THERE seems to be about equally divided opinion as to whether all of the rules should be in one book or if each division of the work should be covered by an individual pamphlet.

Some contend that all employees should know all of the rules, those that govern the other fellow as well as those governing himself, so that in case of transfer, he would know what was required, as also he would be better able to cooperate with his fellow-workers.

Others think that to incorporate all the rules in one book would make it too bulky, as well as unnecessarily expensive; that it would not be read and memorized, especially by the linemen.

Others contend that there should be separate books for each field of endeavor, since the more complicated the rules are, the less practical they will prove to be; and to be of value they should apply definitely to particular work. All divisions of work might therefore be covered under distinct headings in one pamphlet, although a lineman will not read through the rules of other departments to locate those applying directly to his work.

Perhaps the better way would be to have separate pamphlets for each division, one for chief engineers, division engineers and district foremen of all departments; one for the electric distribution department, for the district foremen, foremen and workmen; one for transmission and substation division, for the division foremen, foremen or chief operators, operators and workmen; one for the generating stations, for the chief operators, chief engineers, foremen, operators and workmen; one containing special rules for safety organizations, resuscitation and first aid, to go with any one or more of the above.

Undoubtedly one book should include rules both for the foreman and the workman, because the workman can then know the foreman's rules as well as his own and can check him on safety; and when some day he is foreman, he will know what is expected of him for the protection of all.

It seems to be general opinion that a few fundamental explicit rules that can be enforced are better than rules to cover every operation, which would destroy initiative in the workmen.

Some contend that all rules should be iron-clad while others say there should be iron-clad rules for certain operations, other operations being covered by safe practices. Where there are a few fundamental safety rules or laws, there should be a standardized operating code book for details of the work. As near as can be determined before actually writing the rules, ten to fifteen should be enough to cover safety laws in each department.

Opinion is equally divided about the advisability of including disciplinary penalties in the standard code, although the consensus of opinion is that rules should be enforced in order to be valued, and some consider that disobedience, neglect or rule-breaking are sufficient grounds for penalty to be determined in each such case.

It is generally conceded that a rule book is not enough for a lineman, especially as many are inexperienced. Some think the foreman should be instructed, he to instruct the linemen; others think that instruction in class with an occasional examination should supplement the rule book; and still others consider reviews or instruction at assembly points or in camp to be more advisable, as classes are often a bore.

General opinion seems to be that first aid instruction should be included in the book and some think that fundamental hygiene should probably be included as well.

It is agreed that the book should be about 4 x 6 in., so that it can be carried in the pocket, of a loose leaf type to permit addition or replacement.

* Report of Accident Prevention Bureau, Technical Section.

Accident Prevention Course for Linemen

By F. A. BROWN*

SOME of the Pacific Coast companies are distributing copies of the N.E.L.A. course for linemen. None are conducting a course as such. The Pacific Gas and Electric Company and the San Joaquin Light & Power Corporation at the present time have line instructors who were for a number of years engaged in line work. These line crew instructors spend the necessary time with each crew to see the performance of all

* Report of Accident Prevention Bureau, Technical Section.

classes of work. If any unsafe methods or practices are in use they are called to the man's attention and required to be discontinued and safer and better methods are recommended.

After watching the conduct on different classes of work, if careless or incompetent men are found they are cautioned and the attention of the foreman and superintendent called.

The line instructor sees that the necessary safety devices are carried with each crew and where others are needed he recommends them to the proper authority. In addition, th Pacific Gas and Electric Company's instructor on the last day of the visit with each crew recites the fatal and serious accidents of the past few months, explaining the causes and prevention.

The San Joaquin instructor is primarily engaged on maintaining construction standards. The apprentices are stepped up to linemen's rating at the end of a specified period of time, provided they can do the work of a lineman, but without an examination as to their proficiency or their knowledge of safe practices and the company's rules and regulations, except as they have demonstrated such knowledge in their daily work to the satisfaction of the foreman under whom they are working. Other companies have the same promotion arrangement for linemen.

The consensus of opinion is that the success of an educational course would depend somewhat upon the manner in which the course was given. If the men were required to take such a course upon their own time, very little interest would be taken, especially by the older men, and one construction superintendent writes that he does not consider such course practical to conduct in that manner.

The printed course provided by the N.E.L.A., placed in the hands of the linemen, however, is considered and proved of value and further interest would be stimulated if promotion depended upon proficiency in this course.

The opinion of the majority is that we might find some of the foremen taking exception to having their old methods questioned or perhaps condemned, and this condition would, of course, have to be corrected by first educating the foreman.

Suggestions

One of the causes of accidents is lack of knowledge. The need for training linemen in safe practices is unquestioned. Such education in any line of work has a telling effect in the prevention of accidents and by increasing efficiency because in addition to educating the man we teach him to think. The scope of such a course should cover the various safe practices.

Tests may be practical, by observation of a man's daily work and if desired, supplemented by oral or written examination.

It is suggested that there should be placed in the hands of every lineman a copy of "Accident Prevention Course for Linemen," prepared by the Accident Prevention Cummittee, National Electric Light Association, 1924.

After the men have had opportunity to study it, a section or two of this course could well be reviewed and discussed at the various forms of employee gatherings, such as when the instructor brings the linemen together at the close of his visit in a district, or at the club or social gatherings when refreshments and perhaps entertainment may be provided and employees' families invited.

At these times the apparent proficiency of the men should be noted by observers and recognized according to merit.

Safe Practices

By W. L. SMITH*

IN order that the extent of improvement of safe methods used in the construction and operating field of the public utility and also that the development of safe practices might be determined, an inquiry covering certain well recognized safe practices, as well as some less known, was sent to the members of the committee representing various utilities on the Pacific Coast. Every one responded and their comments are reflected in a discussion of the following questions:

* Report of Accident Prevention Bureau, Technical Section.

General Practice of Placing Electrical Equipment in Service

This was discussed from two angles, the first being that recognized necessary tests and inspections be made by those responsible for the construction and installation of the equipment in question. Second and perhaps most important from the standpoint of safety is that of transferring the equipment from the construction to that of the operating department's hands. One company states that the construction engineer serves notice to the operating engineer that equipment, where same is required and is available, will be completed at a date specified in such written notice.

Upon such notification being given to the operating engineer, all such equipment as high voltage lines, feeders and branch primaries, arc-circuits, station or other equipment as the case may be, on and after the date specified in the written notice, shall be considered live and in regular service. It **must** be presumed by all concerned that the equipment is in operation and therefore no work shall be done upon it by anyone in the construction department or under the supervision of the operating department without first obtaining authority and clearance from the operating department in the regular manner. It is important, therefore, that construction engineers make sure that all employees under their supervision understand this working arrangement prior to the date specified in the notice to the operating engineer that such lines or equipment will be placed in operation on the date specified.

In the event that the lines or equipment are needed in an emergency and are placed in service prior to the date specified in the notification, sufficient counter written notification must be made and all employees concerned thoroughly informed of the new working arrangement.

The importance of the operating department being fully informed regarding condition of work done on any portion of the high tension system is also manifest.

Safe Method of Handling Clearances

(1) All companies have a standard practice for the issuance of all clearances by the operating department, to be centralized in load dispatcher's office.

(2) Clearances must be given only to authorized parties.

(3) Sufficient notice to dispatcher is required, in most companies; either one day's notice or special permission from the operating engineer's office is required before a clearance is granted.

(4) Party requesting clearance should make an indedendent check of disconnection of such lines or equipment and also is required to wait for the personal and definite statement that he has a clearance before beginning work on same.

(5) All statements in connection with clearance shall be repeated to eliminate any misunderstanding, clearance not to be given if telephone communication is not thoroughly clear.

(6) Load dispatcher and station operator log all details of clearances, some companies also require patrolmen and others to keep memoranda concerning their part of the clearance.

(7) In no case will any additional party work under a clearance unless they are working directly under the supervision of the first party who has taken out the clearance, this applies either to line or station equipment.

A patrolman or substation operator usually acts as representative from the dispatcher's office, giving the clearance to the party in the field or substation who is authorized to do such work. The substation operator instructs the second party to place his own short and ground before starting the work and must keep the dispatcher's office informed as to the nature and progress of work accomplished and detail any changes made under his clearance, also to arrange with dispatcher for the transfer of clearance to next man coming on shift if it is not completed during his particular shift.

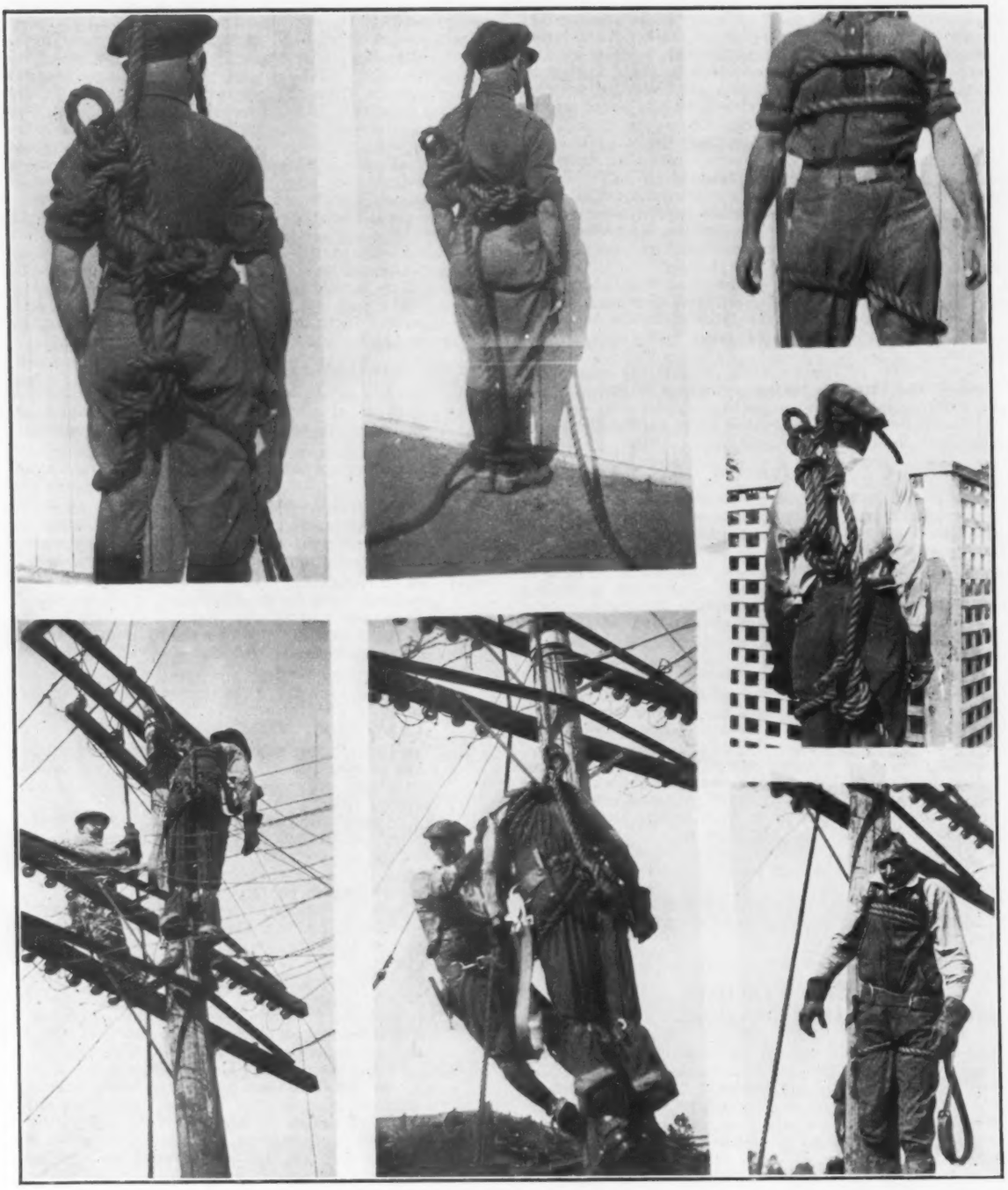
The patrolman in delivering a clearance to a second party places a short and ground on the line in sight of the second party, the same patrolman is responsible for turning in clearance to the dispatcher's office after removing the short and ground.

It is usual procedure in all companies to sectionalize lines or equipment, and in the case of lines, to short and ground at both ends as well as the point where work is being done. (This rule is intended to protect against a cross which might occur from a failure on lines of other utilities as well as the company concerned.) The most approved type of procedure for shorting and grounding lines is as follows: The ground wire or chain is first made secure to a good ground through an approved clamp, the other end of the line is fastened to a cotton sash cord. This cord is thrown across the line first, the patrolman or workman pulls the ground wire or chain (using rubber gloves) across the circuit he is attempting to ground, thus shorting as well as grounding it. The pulling of the ground wire or chain taut completes the operation in the case of the line grounding. A more solid ground, however, is made in the case of equipment and buses in stations, a clamp being fastened to ground first and then to the bus or equipment.

(8) In practically all companies maintenance crews working under the supervision of the operating department and making periodical inspection of equipment must follow the same procedure as other workmen in obtaining clearance from the dispatcher.

(9) Tags or black, wooden blocks with the words (printed in red), "Men at Work" or "Men on Line" cover controls of all switching gear while clearance is in effect.

(10) Finally, the success or failure in carrying out the procedure of clearances depends upon the



Views showing the method of lowering an unconscious man from the top of a pole, using the scheme devised by the fire departments of some of the large cities

close cooperation between the parties handling the work on the clearance and the load dispatcher. This necessitates that all employees concerned should be thoroughly coached and made to realize that every possible safeguarding is in the interest of their personal safety.

Safe Method of Operating the Two-Circuit Peddler Line System

This is particularly a system where large industrial consumers are supplied with two high-voltage lines, say anywhere from 10,000 to 35,000 volts. The consumer may run on either line and do their own switching to the other line in case of interruption to service.

Reports from three companies state they have no circuits of this character, three other companies state that in connection with this type of circuit the dispatcher does the ordering of patrolmen, troublemen or operators in connection with switching or clearances in the particular industrial substations. Clearances are handled in same manner as on single-circuit lines with the addition of a special caution to workmen to the effect that the second circuit is or is not energized.

One representative reports that inasmuch as consumers cannot be depended upon to report any switching, they are not requested to make any report of it. Therefore after any interruption, it is absolutely necessary to make a check of all these consumers before doing any line switching. Switching of these consumers' substation by the consumer does not parallel the lines, due to the switches being mechanically interlocked. Patrolmen or troublemen may, by unlocking this interlock, parallel the lines and thus change a consumer from one line to the other without an interruption to the consumer. Patrolmen or troublemen must replace and lock the interlock mechanism. The dispatcher must check the locking of this device and make an entry in his log to show it. Any such switching by the patrolmen or troublemen must be done only on direct orders from the load dispatcher or his representatives in the outside districts.

Linemen must not work on any section of line involved in these double circuit consumers' substations until all pole tops (or disconnect switches) on that section of line at such consumers' substation have been opened.

Consumers have keys to their substation building or enclosure, but do not, and should never have keys to either pole top switches or oil switch interlocks.

Safe Method of Lowering Injured Person from Top of a Pole or Other High Place

Replies from all companies seem to demonstrate the fact that there is no recognized standard method in overhead line practice covering this operation.

It is realized that conditions may vary considerably in the position of an injured man on a pole and a standard method may not apply. Linemen, however, are usually resourceful in handling a rope in this case; they may be a little rough with the victim but they get the victim down before it is too late to apply first aid or artificial respiration.

One company states that the rope is placed around the victim's arms then through the D ring of the safety belt, if a belt is being used. If victim has no belt on, the rope is placed around the victim's waist then around the body under the arms. This will take the pull of the rope from under the arms as one is being lowered.

Another explains a method of using two half hitches —one below the hips, one under the arms—to make a sling. This method is crude but effective. A variation from this is to use the belt and in addition use a bowline hitch around the arms and body to keep the victim from falling through his belt, in all cases the working end of rope is passed over the nearest adjacent crossarm to lower the victim.

One company investigating the simplest and quickest means for lowering the victim adopted the method as used by the fire departments of several large cities as the easiest to apply and one in which the victim is less likely to be further injured. Special mention is made of Captain Samuel H. Calderwood, of the Los Angeles department, who originated the method. The following is offered as a suggestion:

Using a ¾-in. manila rope which is usually available, make a double bowline on a bight, bringing the loops up around each leg to the thigh, then bring the working end of the rope up, making two half hitches under the arms and chest, locking these two half hitches by another half hitch so that the rope cannot slip either way. By this method the body is supported mainly at the hips and the rope cannot bind or cut the body.

This suggested method is demonstrated in the accompanying pictures. The top center picture illustrates a method particularly applied to lowering a woman from a burning building. In this case the rope is applied around the ankles instead of at the ribs.

Safeguarding Against Explosion and Asphyxiation in Manholes and Tunnels

The following reports regarding practice of above subject were received from various companies:

The California Oregon Power Company—Have no manholes.

San Diego Consolidated Gas & Electric Company—Gas masks provided, kept clean, sterilized and always ready for service. H. H. inhalator used supplementary to artificial respiration in case of asphyxiation.

The Southern Sierras Power Company—No provisions needed in its operations.

Pacific Gas and Electric Company—Have gas masks in each division cared for by gas department but often loaned to electric department to disconnect burning apparatus.

Great Western Power Company—Use and maintain gas masks for operating in manholes.

Southern California Edison Company—Use suction fan and after it has run for short time a piece of lighted waste is dropped in the manhole. This is called shooting the hole. It has been proved that pump will clear all gas if left running long enough.

San Joaquin Light & Power Corporation—Did not answer.

Los Angeles Bureau of Power and Light—Provides proper ventilation on new construction work. In testing for artificial or illuminating gas that might have leaked into manhole, the Kohler miners' safety lamp has been found very satisfactory for determining approximate percentages of gas or if air in manholes has a deficiency of oxygen. Sufficient gas masks are provided and maintained for the use of the men working in manholes.

Conclusion

Heretofore the subject of safe practices has been discussed briefly and there seems to be a common agreement that the matter of safe practices should be incorporated into the standard safety code and especially in an accident prevention course. It is only by the widest dissemination of this knowledge that the greatest good can be achieved in the elimination of accidents and fatalities.

Safe Tools and Devices

S. M. Bullis*

ONE of the best arguments for accident prevention is that is does not entail loss of efficiency nor impairment of service. Each time a safer tool is developed a more efficient practice is effected, and a man working safely with a safe tool is more efficient and loyal than one with poor tools. The support of those in charge of operation and maintenance is secured only when it is proved to them that safe work is as rapid and efficient as unsafe work. Introduction of tools permitting efficient accomplishment of necessary maintenance and operation, at the same time minimizing personal risk to the operator, offers that proof.

At the time when uninterrupted service was not imperative, maintenance work could be accomplished with the tools ordinarily used for construction by killing the line. Today many processes and industries require as continuous a service as it is possible to render. This, together with the growth of industry, has demanded heavier construction and intricate connections.

The lineman still cling to their traditional desire to be "juice eaters," but it is difficult to go before a jury and blame the injured man when the first inquiry might be "Were proper tools and protection supplied?"

Tools for handling hot lines amply justify themselves from an efficiency standpoint, by reducing the lost time of switching, which often was greater than that required to do the job. It has been demonstrated that a picked crew of good linemen will actually do the job itself quicker, and they like their work better, and without taking any chances at all they get a greater "kick" out of their work than they did even in the old times when linemen handled 2,300 volts almost bare handed.

The demoralizing effect of an injury to one of a crew, the difficulty of satisfying the workmen that a

*Report of Accident Prevention Bureau, Technical Section.

line or equipment is adequately killed and grounded for his protection, and that it will remain so; the loss of time due to switching, even greater than time lost due to preparation for hot line work, and, beyond all else, the fact that the crew is being trained in safe practices; these are all distinctly advantageous.

This report presents several devices developed on systems of member companies primarily to facilitate work at once described as both efficient and safe.

Most companies use standard equipment, and most of them, in addition, have developed devices for one thing or another. Some of the prominent but least known, perhaps, are set forth as follows, for the benefit of those companies not yet using them.

Dead-end Board or Portable Staging

Two companies offered photographs or prints of portable stages for linemen making dead-ends and for similar work. Fig. 1 shows a patented type used by the Bureau of Power and Light, and Fig. 2 shows one developed by the Pacific Gas and Electric Company.

Still another company uses a board hung with ropes when making up dead-ends with long strings of insulators, or when using long arms on transmission work, when without these devices the linemen are subjected to physical strains due to the positions in which they must otherwise place themselves.

Pole Platform

This is similar to the above except that it is larger and is hung in the front of a pole for more extensive work such as transformer maintenance. (Fig. 3)

[Note: Linemen must be particularly cautioned not to work from any of the above boards or stagings without proper attachment of safety belts, which, as a rule, must be provided longer than ordinary.]

Tester for Street Lighting Circuits

The San Diego Consolidated Gas & Electric Company has an arrangement which the men call a "pea shooter" with which they make a check test on a street or lighting circuit when the ordinary test with magneto is not satisfactory to determine that the circuit is closed. (Fig. 4)

This device employs three dry cells connected to a Ford spark coil enclosed in a box, having on the outside of it a snap switch in a battery circuit, and on top, a spark gap in the secondary or high tension circuit, this gap set to 1/8 to 1/16 in.

Cords with ordinary test clips are provided from the high tension terminals of the coil, the spark gap being in series in one of these terminals.

A man working on the line when a test is made will not be harmed. The use of the set is considered safe and is said to give sure indication and saves unnecessary patroling lines many times.

Wooden Pliers

The San Diego Consolidated Gas & Electric Company developed wooden fuse pliers, which perhaps are more or less known in some form. (Fig. 5.)

Fuse Stick

The California Oregon Power Company provides a device (Fig. 6), which permits of gripping a piece of broken fuse as well as normal fuse handling. The fuse is held in the rubber lined slot by the slide operated from the handle.

"Jackson High Line Hook" for Attaching Hot Taps

The San Diego Consolidated Gas & Electric Company furnished the drawing (Fig. 7) of a device for attaching tap clamps to hot lines.

"Hickey Stick"

The Great Western Power Company has developed a hand tool used in the underground work generally in connection with fuse pliers for changing junction box

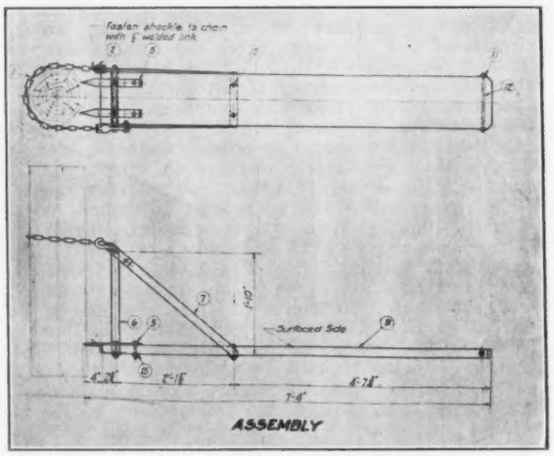


Fig. 2

fuses (Fig. 8). The "Hickey Stick" acts as a socket wrench having a slot to receive the wing nut and springs to hold the swing in the slot so as to avoid dropping the nut. The wooden handle is paraffin soaked.

Grounding Clamp

The Great Western Power Company has also perfected a clamp used for grounding high voltage line conductors. It is built not only to clamp on but to screw up tight to eliminate possibility of becoming unfastened. (Fig. 9.)

"Hot Wire Tester"

The Great Western Power Company also sent a sketch (Fig. 10) of a pencil-like, hard rubber device employing the familiar spark plug testing tube, which glows when placed near a live conductor. We presume that these are not suggested for "testing," high voltage conductors, unless fitted to a suitably insulated handle.

Wrench for Acetylene Tanks

The Bureau of Power and Light recommends a socket type of wrench with straight stem approximately 4 in. long, and with a wheel handle on the end opposite the socket. A raw-hide leather string ties the wrench to the

Fig. 1

acetylene tank, and is an improvement over the ordinary wrench particularly in that it permits closing the valve should the gas hose become broken at its junction with the tank stand and the gas be ignited, in which case it is practically impossible to get the hand close enough to use the ordinary wrench.

Ladders

For electric stations the Great Western Power Company recommends the exclusive use of ladders made of kiln-dried lumber, covered with standard insulating varnish and equipped with non-skid tips. Incidentally

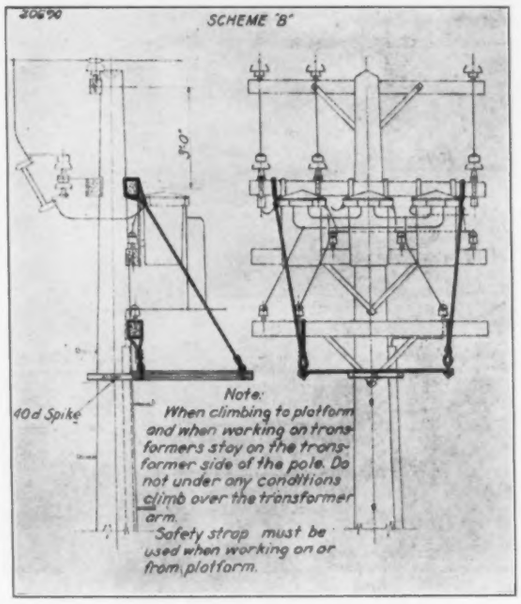

SCHEME "B"
3'0"
40d Spike
Note:
When climbing to platform and when working on transformers stay on the transformer side of the pole. Do not under any conditions climb over the transformer arm.
Safety strap must be used when working on or from platform.

Fig. 3

load bindings are cut. Two ¼-in. ropes of about 115 the proper placing of the ladder and prevention of slippage, are matters warranting considerable education.

Method of Unloading Poles

The Southern California Edison Company employs a method of unloading poles from cars, described briefly as follows:

Special car stakes are placed on the back side of the load, and these stakes are braced to the ground. These are used to support the back side of the loads when the ft. each are made fast at one end to a stake socket on the unloading side of the car, one near each end. These ropes are thrown over the top of the load and a turn taken around the hub or journal box of the car trucks. The unloading skids are then put in place as usual. Next the binding wires and stakes on the unloading side of the car, may be cut safely, the two ropes holding the load back against the braced stakes on the back side of the car. The men on the back side of the car then pay out the ropes, allowing the load to easily settle down on the unloading side.

Device for Grounding Line Wires Being Strung or Removed

The Southern California Edison Company has devised a channel iron plate, fitted with two guide rollers to be clamped to the cross-arm when men are stringing in or taking down a line, either under or over a hot line.

One of these devices is provided for each wire being strung or removed. They are bonded together and grounded, the whole set being used on the first pole away from the reel. Another set is used further along the line, particularly where a good ground was not obtainable at the first pole.

Safety Flag Stand

Because of a number of accidents caused by people driving into guy wires, lead lines, line wire, etc., when down, because often times the flag used for signal was not clearly seen, or had fallen over, the Edison Company has developed a folding flag stand.

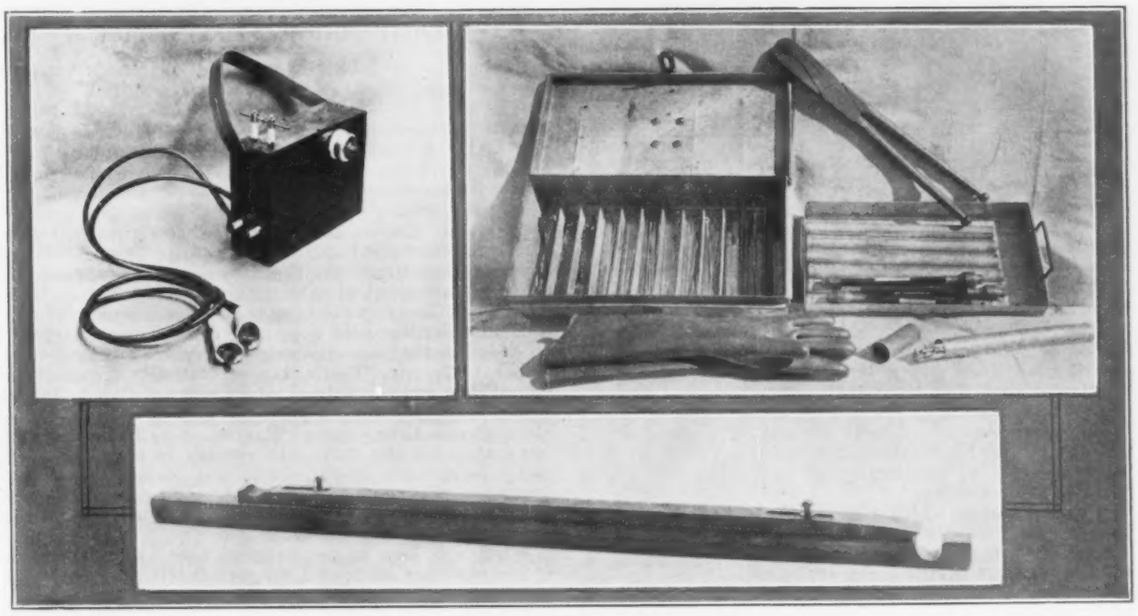
It is made of ½-in. pipe with an 8-in. diameter maleable iron base, having a cross member from which the flag is hung vertically when in service showing the full size of the flag about 2½ ft. above the road. The cross member folds against the stand.

"Hot Tapper"

The Southern California Edison Company has also devised some "hot taps" which are used in bush fuse pullers for making taps to hot 10 or 15 kv. lines, doing away with other forms of tap sticks and reducing the number of tools required to be carried.

The Edison company's transportation department is developing a portable rig which can be placed on the rear end of a 3-ton Mack truck and used for setting poles, the work of raising the pole being all done by a drum and cable operated by the motor through a clutch.

This company also states that pike poles are all 16 and 18 ft. and before being accepted each one is tested by supporting the two ends and hanging a 200-lb.



Figs. 4 (upper left), 5 (upper right) and 6 (bottom)

weight in the center, and revolving the pole, thus testing the pike on all sides.

They are treated with two coats of hot linseed oil as are the handles of all tools needing similar preservation to keep them from getting rough and splintery.

Hot Wire Tools for 10 to 15-kv. Line Work

In order to safely do maintenance work and also tie in new lines etc., without interrupting service, the San Joaquin Light & Power Corporation has developed several very unique and satisfactory devices as well as method or routine of performance.

There are, altogether, twelve different devices for the various operations involved in changing dead-end insulators as well as pin-type insulators, cutting in jumpers and replacing them, not by hot-tap clamps but in a permanent fashion. These are also used for transferring hot lines to new poles and in cutting in new extensions.

In all cases the tie wires, jumpers, etc., are actually served onto the line wire as though by hand.

The tools consist of a tie-stick, wire-clamp, pigtail hook-stick and crossarm clamps for pin-type insulator work and jumper work. For dead-end changes a hot-wire "come-a-long," a tool to apply it to and remove it from the hot line, a crossarm sling, a set of blocks with attachment for applying them to the hot wire "come-a-long" and an "alligator-stick" for handling the insulators and tools are used in conjunction with the above tie-stick and pigtail stick. In addition a special hot-wire cutter is employed.

The tools that are used in contact with the hot wires are equipped with treated wood handles 6 ft. long. This wood is tested to 20 kv. per 6 in. of length. The operator never needs to get closer than 3 ft. to the hot wire.

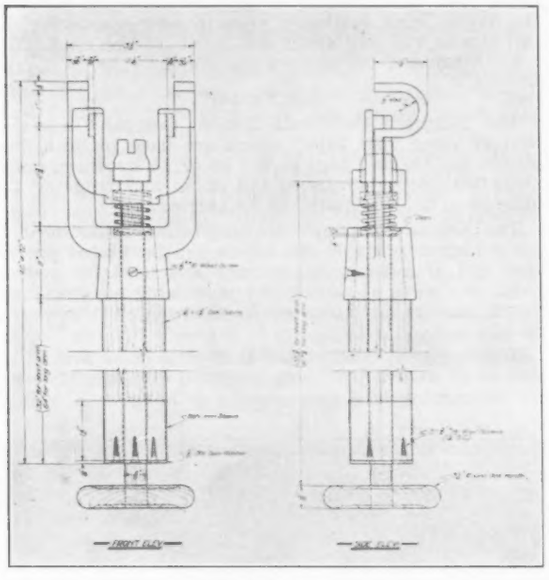


Fig. 7

The tools have been in use on the San Joaquin system over a year and there has not been a single accident to any man using them.

Patent is pending on these tools and they will probably be available in a short while. They have proved themselves on the San Joaquin system and have resulted in a large saving in expense of maintenance of distribution lines and a larger saving in interruption to service that they have obviated.

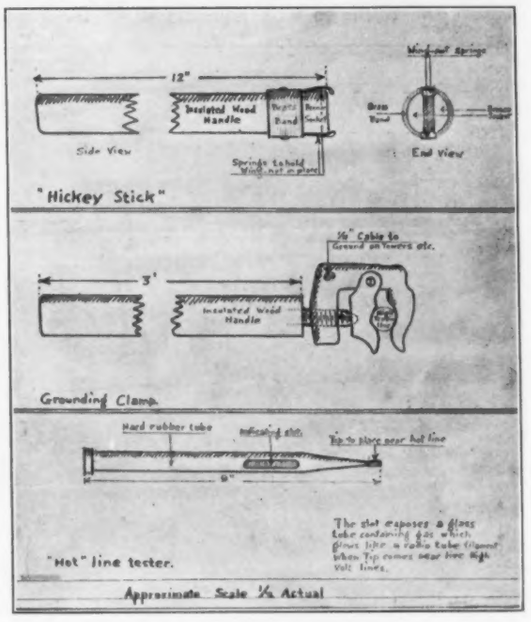
A demonstration of the use of these tools in actual maintenance service, close to the city of Fresno, was a feature of the National meeting of the Technical Section, attended by practically all of the members who were at that meeting.

The manner in which the team of three men (two linemen on the pole and one groundman) worked together with hardly a spoken word, but each right on the job as part of the team every second, was as impressive as the simplicity and speed of the operation, and the safety of it.

In conclusion it is suggested that some of the above devices or their equivalents should be in the equipment of every crew doing work of a character indicating their usefulness.

Lists of tools and protective equipment for each type of crew could and should be standardized at least by each company, there being few standards at the present time even within the companies.

The proper list should, in each case, be in the hands of the foremen of the crew, who should be required at all times to have such equipment available and in serviceable condition.



Figs. 8, 9 and 10 (Top to bottom)

A good workman is worthy of good tools and a safe workman must have safe tools. The work with which these devices are used is peculiarly hand or personal work, and the safety of the man is entirely dependent upon the reliability of the tools with which he works.

Any service, rendered by those entrusted with accident prevention, in promoting or developing tools for safe performance of necessary operation, is of great value.

Distribution Transformer Standardization

By N. B. HINSON*

THIS subcommittee had a small committee meeting of the members in and around Los Angeles and a tentative plan was outlined. The various phases that have been suggested such as case dimension, hanger dimension, arrangement of external leads, arrangement of terminal boards, electrical characteristics, cut-outs, etc., were discussed and the consensus of opinion was that we should consider the first two, that is, case and hanger dimensions at this time.

A blank form giving the main dimensions of 2,300-volt distribution pole type transformer was sent out to four of the manufacturing companies, namely the General Electric, Westinghouse, Maloney and Packard companies, and the data obtained was tabulated. It was found that the four companies named have case dimensions at this time (though this was not true some time ago), that for the same size are nearly identical, especially height and width, front and back. Any transformer of the same rating could replace another make without changes in the clearance to wires below the transformer.

When you look at the hangers such is not the case. In the standard sizes of 2,300-volt distribution pole-type

* Report of Subcommittee, Overhead Systems Bureau, Technical Section.

transformers, 1½ to 50 kva., there are for the four manufacturers many different hangers. There seems to be no reason why the main hanger dimensions could not be standardized, just as numerous other devices, without affecting the design of the main product.

By standardizing on one main dimension of hangers and transformer supporting lugs, four and perhaps two hangers would take all makes and sizes of pole-type 2,300-volt distribution transformers.

There has been some discussion regarding the elimination of that part of the hanger iron which sticks down below the bottom of the transformer case as the transformer cannot be set down with the hangers attached. Some Western operating companies are now using hangers with this part cut off. This extension has been

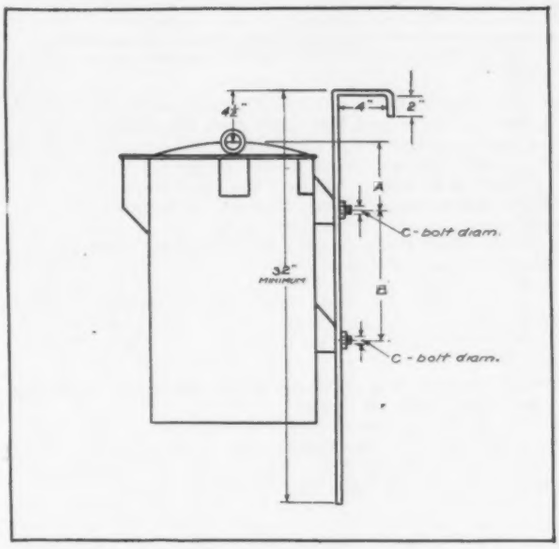


Fig. 1—Typical 5-kva. transformer on proposed standard hanger.

used by some companies to bolt the hangers to the heel arm, but the hole in the top bend of the hanger can be used to bolt the hanger to the top supporting arm when necessary.

The definite recommendations this committee has to make, which are concurred in by most of the member companies, especially those along the Pacific Coast are: (1) That the minimum length of transformer hanger be 32 in.; (2) That for transformers of 15 kva. and larger, the hanger should not extend below the bottom of the transformer case; (3) That all transformers should be designed to mount on the hangers so that the top of the case will be 4½ in. below the top of the hanger iron support; (4) That the hanger iron top should be designed to fit over a 4-in. crossarm and have a lip on the hook extending down 2 in. These dimensions are shown in Fig. 1. We would recommend that the various manufacturers get together and standardize on the dimensions "A" and "B" and diameters of bolts "C" for certain sizes of transformers. This would probably require two or at the most four hangers.

It has been suggested that all transformers larger than 25 kva. be carried in stock without hangers and that hangers for these sizes be purchased as extras. These larger size transformers are mounted on platforms in a great many cases and the hanger irons accumulate in the storeroom.

The fact was brought out that most Pacific Coast companies do not use the lugs on the secondary leads, but cut them off and these accumulate in stock, and that it would be advisable to furnish transformers without secondary lugs. The suggestion of using rigid secondary leads instead of the present flexible ones was discussed, but we have no definite recommendations to make at this time. This, together with the proposition of 4-coil secondaries permitting the use of transformers, either for 110-220 or 220-440 for primary voltages of 6,900 or higher, arrangement of terminal boards, primary cut-outs, etc., will give this committee material to start work on next year.

Testing High-Voltage Insulators in Service

Report of High-Voltage Insulator Committee, Overhead Systems Bureau, Technical Section*

IT has been the endeavor of this committee to gather data covering the methods in use in testing high-voltage insulators in service by the member companies and also to get information regarding equipment either available or in process of development for making such tests.

The information obtained to date is not nearly complete but shows the following general practice. Nearly all companies reporting have used the megger test in the past with more or less satisfactory results. One company reports satisfactory results on suspension units with the megger except for the fact of its being sometimes impractical to de-energize a line. Another reports perfect satisfaction with the megger test for suspension units, but that it uses a spark coil and X-ray set for pin-type insulators. Another declares the megger impractical as it often shows a great many units as bad which are in reality O.K. Some very interesting comparisons of results from megger tests and standard 60-cycle and high-frequency tests were submitted by The Southern Sierras Power Company, reference to which will be made later.

Many of the replies indicate that a method of testing insulators while the lines are energized would be very acceptable. More or less experimental work has been done in this regard. This is particularly advantageous in view of the wide interest in "hot wire maintenance" of lines of medium voltage. Following is a report from the Southern California Edison Company regarding the development of an instrument for testing insulators while energized.

"Under present conditions no attempt is being made to test insulators in service. Our usual practice is to de-energize the line to make an insulation test of the individual units, checking up an insulator string by means of a megger. This method has been successful and satisfactory but has its limitation. It is quite difficult to test insulators on a certain line if no provision has been made to handle the service by means of another transmission line. Some lines can rarely be taken out of service.

"In the past some equipment has been developed for the testing of insulators while they were in service and the line was energized which offered considerable promise. This consisted of two aluminum vanes set inside of a square tube of bakelite around which a square tube of brass was mounted. Over this square tube of brass another square tube of bakelite was attached. The two aluminum vanes constituted one pole of the instrument, while the square brass tube constituted the other pole. From these two poles, or terminals, leads were brought to two middle prongs used for spanning individual insulators in an insulator string. The whole equipment was mounted on the end of a 5-ft. treated wood stick. In testing the individual insulators were spanned and the defective insulator was indicated by a very slight movement of the aluminum vanes, whereas an insulator in first class shape would show a movement of about ½ in. in the ends of each of the two vanes. This equipment was developed for use on 10-kv. and 15-kv. distribution circuits and under experimental conditions it seems to be a very satisfactory and reliable instrument. However, it was found that the principle upon which this instrument operated was an apparent infringement upon one of the claims of O. F. Johnson who had developed the "buzz stick" method of insulator testing, consequently further development of this equipment was abandoned and it has not been used on our lines. The matter has lain dormant for approximately two years and the prospects for resurrecting it seem somewhat dubious at present. Apparently all schemes seem to be a violation of some

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part of Mr. Johnson's claim, and we feel that it would not be advisable to go further with the development of this equipment under the present conditions."

A report from the San Diego Consolidated Gas & Electric Company covering the use of the above mentioned equipment follows:

"We have found that testing line insulators in the field either in or out of service is not practicable because we are so near the sea coast that tests with a megger are useless and tests with other devices show so many insulators to be bad when they are not.

"No tests have been made during the past two years, but in 1922 tests were conducted on 11-kv. insulators using the Reed tester developed by the Southern California Edison Company. The report of the test was as follows:

" 'We have completed testing insulators on all 11-kv. feeders and results obtained as follows:

Total number of insulators tested.....10,375
Total number of insulators found bad..... 1,337

" 'Of the above "bad" insulators twenty No. 3538 and twenty No. 3039 were selected at random and brought to the electric repair shop in the condition as found in the field and were tested, with the results as shown in Table I.

" 'Additional tests of strings (four in a string) of new tested insulators were made in the electric repair shop with 11-kv. impressed upon the string with result that the Reed testing stick showed one or more to be "bad." A known "bad" insulator was also tested with the stick and a "bad" result was obtained.

" 'Conclusion: From the above tests it would appear that the Reed testing stick will undoubtedly show up bad insulators, but also will show up as "bad" a large percentage of good insulators.' "

The report of The Southern Sierras Power Company covers work done some years ago on standard 10-in. disc suspension insulators. The failures of these insulators were due mainly to cracks in the porcelain head of the insulator. The report reads as follows:

"When this work was undertaken we had no precedent or past experience of other companies to follow. Being equipped with a 110- to 120-kv., 60-cycle transformer and a 110- to 125-kv. 200,000-cycle oscillator it was first decided to give each insulator unit a 30-sec. test with the 60 cycles flashover and 15-sec. test with flashover voltage from the oscillator.

"It was soon discovered that the majority of the bad units were discovered soon after the application of the stress and that a continued application of flashover voltage caused units to break down that apparently had some insulating value left in them.

"It was finally decided to discontinue the use of the 60-cycle voltage and to establish a routine test of 5-sec. application of the flashover voltage from the oscillator. This test will locate a very large percentage of the bad ones with an expenditure of a minimum amount of time.

"We have observed that our regular suspension type insulators with a 10-in. disc requires a voltage of about 80,000 to flashover.

"From the records made while testing at the steam plant with both 60 cycles and oscillator we found that while testing with the oscillator first we examined 716 units of which 187 bad units, or 26 per cent, were found with the oscillator, after which 113 more bad units, or 15 per cent, were found with the 60-cycle test. While testing with 60 cycles first we examined 897 units, of which 361 units, or 37.8 per cent, were found to be bad, after which 123 more bad units, or 12.8 per cent, were found with the oscillator test. While this would indicate that the 60-cycle test was more effective, it must be borne in mind that the 60-cycle test was for a period of 30 sec. and the oscillator for only 15 sec. Later, while in the neighborhood of the control station, we examined 198 units first with a 5-sec. 60-cycle test, finding one bad one, after which a 5-sec. oscillator test was applied to the same units, finding 24 bad ones, or 12 per cent. This result is quite different from the results obtained at the steam plant.

"Again, while at the steam plant, we examined 983 units with the high-tension megger finding 80 units, or 8 per cent, to be bad. When these units were subjected to a combined test of the 60 cycles and oscillator, we found 48 per cent to be bad. Later, while at Inyokern we tested 357 units first with the megger, after which they were given the regular 5-sec. oscillator test. The megger showed them all to be good, but the oscillator found 206, or 5 per cent, to be bad. This result illustrates how inadequate the megger is for insulator testing. The insulators at the steam plant probably had sufficient moisture in them to permit the megger to give a reading, while the bad ones at Inyokern were so dry after a hot dry summer that they all measured 'infinity.'

"To date we have examined a total of 47,989 units from the line, of which 12,439 units or 26 per cent have been found to be bad. So far the insulators have been found to be in the worst condition in the neighborhood of Inyokern, where we tested 471 units, of which 243, or 51 per cent, were bad. The insulators which have been in the best condition have come from the neighborhood of the control station, from which in one week, we tested 1,730 units, of which 158 or 9 per cent were bad.

TABLE I.

No.	Style No.	Flash-over voltage	Punctured	Resistance in meg ohms Dirty	Clean
20.....	3538	Over 65 kv. each	No	300 to Inf.	Inf.
20.....	3039	Over 55 kv. each	No	170 to Inf.	Inf.

Note: Out of the group of twenty No. 3039 insulators one was found to be no good.

"We have made observations to determine whether insulators coming from one arm were in any worse condition than those coming from another. The results obtained were as follows:

	No. Tested	No. Bad	Per Cent Bad
Top arm	242	42	17
Middle arm	228	42	18
Bottom arm	233	43	18

"The results are so close that they may safely be called alike from all arms."

"We have also reviewed our records to determine if the position of the unit in the string had anything to do with its being bad. From the records of nearly 6,000 bad ones we have the following results:

	No. bad	Percent of total
No. 1 (nearest arm)	863	14.8
No. 2	972	16.6
No. 3	1,015	17.3
No. 4	971	16.6
No. 5	979	16.7
No. 6 (nearest conductor)	1,034	17.7

"Again we have observed that there is very little difference between dead-end suspension towers as far as bad insulators are concerned. This is shown by the following:

	Tested	Bad	Percent bad
Suspension towers	2,407	520	21
Dead-end towers	2,417	453	18.7

"We have found that a great majority of the insulators fail through cracks in the head of the unit; breakdowns occurring between the end of the pin and the inside of the iron cap. Only about 5 per cent of the failures have occurred through punctures outside of the iron cap. Most of these failures have occurred through original defects in the porcelain.

"We have not found that failures have occurred any more frequently among insulators of dark, than of light color, color being an indication of the extent of firing.

"There is one question which we consider important and which we have not been able to satisfactorily answer; that is, what takes place in an insulator between the time that the spark over voltage is applied and when failure occurs, which time may be 3, 4 or 5 sec.?"

The Great Western Power Company has developed a "Glow Stick" for testing insulators on lines operating at 22 kv. and under, which has proved very satisfactory in practice. It consists of two terminals shaped to span the insulator under test. An air gap, condenser and electrostatic glow lamp are connected between these terminals, the lamp being encased in a black enameled hood to help visibility. The equipment is mounted on an insulated wooden handle and the lamp so situated that it may be seen easily by the operator.

The San Joaquin Light & Power Corporation has in use a portable radio receiving set which was built primarily to chase down radio trouble but has proved

quite efficient to detect leaking insulators as well. Aside from the use of this set the megger has been used with quite satisfactory results. Recently a large number of old pin-type 60-kv. insulators which were salvaged from a line have been tested with the megger. They have shown a large percentage bad. It is the intention to check this test with a laboratory test, the results of which will be available for a future report.

The subject of hot wire maintenance was added to this committee's work at the Fresno meeting. There has been developed by the San Joaquin Light & Power Corporation a set of insulated handled tools for this purpose which have proved very satisfactory. The tools have been used on their 11-kv. lines for about eighteen months and some work has been done on 30-kv. lines with them. There is in each district a "hot wire crew" consisting of two linemen and one groundman who do all the 11-kv. hot wire work and in addition handle the patrolling of the more important lines. By the use of the tools they are able to repair faults immediately when found and thus in most cases save possible serious damage that would cause an interruption of service. In addition they follow up the line crews and do such work as transferring hot lines to new poles set in line, make permanent taps to existing hot lines for new extensions and in general handle any work of a hot nature.

On the San Joaquin system these hot wire crews have been a big success as is shown in Table II which summarizes the work done during the first three months in 1925. By subtracting the total in column 8 from column 12 it may be noted that 656 crew hours or 32 crew days have been saved by using the hot wire tools and by subtracting the total in column 9 from column 13 that 6,363 miles less distance has been covered by the crews in going to and from work. The savings in these two items alone may be figured as follows:

TABLE II.—Hot wire tool report of San Joaquin Light & Power Corporation Jan. 1, 1925 to March 31, 1925.

	Work performed using hot wire tools								Necessary if same work performed without hot wire tools			
District	Dead-end insulators replaced	Broken pin type insulators replaced	Broken fuse contact insulators replaced	Broken or rotted pins replaced	Jumpers made permanent	New poles tied in line	Crew hours to perform work	Miles driven to perform work	Transformer banks out of service	Sectionalizing switches to operate	Crew hours to do work	Miles driven to do work
Madera	42	10	....	3	158	11	122	1,445	1,108	197	202	2,014
Fresno	159	43	24	29	382	32	464	2,490	2,077	765	636	4,307
Selma	38	17	5	2	206	48	231	1,689	3,577	310	431	3,160
Merced	387	54	9	19	146	7	207	1,455	1,484	261	318	2,555
San Joaquin	156	16	....	1	58	3	51	504	1,110	101	69	853
Dinuba	148	3	....	....	99	7	115	711	1,120	180	136	1,170
Corcoran	353	43	....	2	85	23	142	933	2,282	178	196	2,541
Totals	1,283	186	38	56	1,134	131	1,332	9,237	12,758	1,992	1,988	16,600

82 Crew days saved at $18.50 = $1,437.00
6,363 Miles saved at 0.06 = 381.78

Saving in labor and mileage = 1,818.78

The saving effected in labor and mileage alone is quite an item but the big advantage is in the maintenance of continuous service that the tools made possible. In handling this work on the San Joaquin system there has not been a single accident.

It is our recommendation that the work of this committee be continued next year and that the subject of "hot wire maintenance" be assigned to it also. It is our thought that the two subjects are closely allied and, with the ever increasing necessity of continuous operation, hot wire work for all voltages is being forced upon the operating companies.

Various Phases of Metering

Report of Meter Bureau, Technical Section*

IT has been the effort of the Meter Bureau to limit the year's work to a few important subjects, it being our belief that by so doing more complete and authoritative reports could be compiled with less burden upon the membership. Eight subjects were undertaken, details of which are given later in this report. A brief outline of these subjects with recommendations for the future may perhaps be in order at this point.

The education of meter men has been a live subject for three years, the efforts of the bureau being directed toward cooperation with the University of California in the presentation of short courses for meter men during the summer session. The courses have been very successful, both from the point of view of the men enrolled and of the utilities by whom they are employed, and it is planned to make these courses a permanent feature.

The bureau has been gathering data relating to a meter test period for some years, and recommends that this study be continued.

A committee on safety rules and test facilities serves as a point of contact with the Safety Rules Bureau, and its continuance is recommended.

The use of oil in meter bearings has been studied in the past from utility experience, and this year's report is based on material obtained from the meter manufacturers. The bureau feels that no further information is obtainable at the present time, and suggests that the subject be temporarily discontinued.

Maintenance of relays has been a subject of past study and its continuance is recommended. This year's effort has been directed toward an investigation of the effect of wave form on time of operation of induction relays, and a very complete report has been prepared with recommendations covering test methods to obviate errors insofar as possible.

A paper on low cost high-tension metering of sufficient accuracy for operating purposes, though not necessarily accurate enough for billing, is presented, and further study of this subject is suggested.

The committee on new developments has reported a number of interesting matters and the bureau offers the recommendation for next year that an investigation be made of some of the devices covered by this report.

The proper size of meter for various different classes of installation is a new subject which was undertaken this year. A considerable amount of data has been gathered but the membership feels that collection of further information is desirable.

* G. H. Searle, Pacific Gas and Electric Company, chairman; J. E. Bridges, Westinghouse Electric & Manufacturing Company; J. C. Abel, Western States Gas & Electric Company; J. C. Albert, Los Angeles Bureau of Power and Light; A. F. Blecksmith, Duncan Electric Manufacturing Company; T. S. Capek, Pacific Gas and Electric Company; G. A. Collins, San Joaquin Light & Power Corporation; L. Conrad, Southern California Edison Company; R. Crowell, Pacific Gas and Electric Company; R. S. Daniels, The California Oregon Power Company; R. S. Duesbury, Western States Gas & Electric Company; E. Ealson, Southern California Edison Company; W. R. Frampton, Southern California Edison Company; T. P. Garrett, San Diego Consolidated Gas & Electric Company; C. F. Gilcrist, San Joaquin Light & Power Corporation; A. J. Hall, Ontario Power Company; Lou Johnston, San Joaquin Light & Power Corporation; R. G. Jones, The Southern Sierras Power Company; T. E. Knackstedt, The California Oregon Power Company; W. G. Knight, Great Western Power Company; O. A. Knopp, Pacific Gas and Electric Company; W. N. Lindblad, Pacific Gas and Electric Company; W. A. McMeekin, Los Angeles Gas & Electric Corporation; L. A. Mott, Sangamo Electric Company; J. H. Paget, Great Western Power Company; A. S. Price, Southern California Edison Company; F. A. Redding, Southern California Edison Company; J. J. Skinner, The California Oregon Power Company; D. D. Smalley, Midland Counties Public Service Corporation; W. E. Smith, General Electric Company; W. H. Talbott, San Diego Consolidated Gas & Electric Company; L. D. Tycer, Pacific Gas and Electric Company; W. C. Wells, The California Oregon Power Company.

An important feature of the year's work has been a closer cooperation with the Meter Committee of the National Electric Light Association than has been possible in the past. Requests for information and opinions have been received from several of the chairmen of subcommittees of the national Meter Committee. All such requests the Meter Bureau has endeavored to answer promptly and fully. In this connection it seems timely to remark that those desiring information should make due allowance for our geographical location and the wide territory over which the Pacific Coast Electrical Association membership is spread. As much time as possible should be allowed for gathering data, and for correspondence between the chairman and members of the bureau in order that the information secured may be compiled with the greatest care and the opinions offered may accurately reflect the consensus of opinion of the membership. It is our earnest hope that cooperation with the national Meter Committee shall continue, as on it our success depends in a great measure.

Education of Metermen

The second annual Short Course for Metermen was held at the University of California at Berkeley, May 19-24, 1924. It had been found in 1923 that the greater demand for instruction came from men of some considerable experience in meter work. It is of course necessary to provide instruction also for the comparatively inexperienced, and the 1924 course was accordingly planned to give the necessary work for beginners, and with optional experiments of a more advanced nature.

Allyn G. Smith of the technical department of the Extension Division of the University, made arrangements for the course, which was presented by the members of the electrical engineering department faculty. In addition to the faculty members, lectures were given by W. N. Lindblad, Pacific Gas and Electric Company; A. V. Guillou, California State Railroad Commission, and O. A. Knopp, Pacific Gas and Electric Company. Representatives of the manufacturers arranged for the loan of apparatus, which was found very helpful.

Forty-nine men attended the course, of whom fourteen had attended the previous course. It is felt that the instruction was of great benefit to all who participated, and it is of interest to note that a resolution of appreciation was adopted and signed by the men in attendance.

The schedule of lectures was as follows:

One Lecture—Fundamental Electrical Principles.
One Lecture—Indicating Meters.
Three Lectures—Principles of Alternating Currents.
One Lecture—The Induction Principle.
One Lecture—The Single Phase Watthour Meter.
Two Lectures—The Polyphase Watthour Meter.
One Lecture—Demand Meters.
One Lecture—Instrument Transformers.
One Lecture—Protective Relays and Their Uses.
One Lecture—The Mechanical Construction of Electric Light and Power Rates.

The course embraced the following laboratory experiments:

1. Series and Parallel Resistances.
2. Alternating Current Measurements.
3. Power and Power Factor in Three-Phase Circuits.
4. Instrument Transformer Connections.
5. Test of Single-Phase Watthour Meters.
6. Single-Phase Watthour Meters on Polyphase Circuits.
7. Test of Polyphase Watthour Meters.
8. Examination of Maximum Demand Indicators.
9. Test of Maximum Demand Indicators.
10. Examination and Test of Induction Overload Relays.
11. Transformer Load Test.
12. Calibration of Indicating Instruments.
13. Measurements of Kva.
14. Performance of an Instrument Transformer with Change of Secondary Burden.
15. Standardization of a Rotating Standard.
16. Oscillograph Study of Third Harmonic Effect in Transformers.
17. Oscillograph Study of Current Transformers on Open Circuit.
18. Inspection and Operation of Various Types of Protective Relays.
19. Examination of Single-Phase Watthour Meters.
20. Examination of Polyphase Watthour Meters.

Mr. Duesbury and Mr. Redding have been conducting arrangements with the University for a third annual course. It was expected up to very recently that this course would be given May 11-16, 1925, but word received from the University would make it appear that it may be impossible to present a meter course this year. This is due to no lack of attention on the part of the Meter Bureau or its representatives, but rather to inability of the electrical department of the University to handle the work. Owing to late receipt of this word from the University it is probably impossible to arrange for the instruction to be given elsewhere.

Meter Test Period

The Meter Bureau has for some years been gathering information relative to the sustained accuracy of watthour meters. Compilation of data is being continued, but material received since the last report is not of sufficient volume to warrant further report at this time. It is the announced intention of the bureau to continue this study.

Safety Rules and Test Facilities

As safety rules are of vital interest to the Meter Bureau, a committee was formed to provide a means of keeping the members in touch with the work of the Safety Rules Bureau and to gather information relative to new developments in the field of testing facilities. As there have been no noteworthy developments, no report is offered at this time.

Use of Oil in Meter Bearings

By E. A. EALSON*

IN an effort to obtain a wide and expert opinion on this subject a questionnaire was submitted to the leading meter manufacturers. The result showed a diversity of opinion from the various standpoints involved. Out of four questionnaires, three submitted data and since the fourth did not, we are led to believe that they do not consider the use of oil in meter bearings necessary.

Three of those supplying information were agreed that oil on the lower jewel bearing was advisable, also that the jewel bearing should be cleaned and oiled on each test and a liberal amount of oil applied.

One method of applying oil to bearings in the laboratory was with the aid of a pipette. This is a glass tube similar to a thermometer tube having a small aperture with both ends open. The oil is drawn into the tube by means of a vacuum and is held there by capillary attraction, but when it touches a jewel surface, it runs out, filling the cup. Another method suggested was the use of a watchmaker's glass oil cup. This cup is provided with only a few drops of oil at a time and can be kept covered when not in use. The oiler may consist of a short piece of .015 brass or phosphor bronze wire inserted in a small wooden handle. The end of this wire may be spread out and flattened slightly at the extreme point which operation will enable the oiler to retain a drop of suitable size when dipped in the oil receptacle before mentioned. This oil cup is shallow to prevent the oiler from being dipped too deeply into the oil, thus retaining too large a drop,

No better method of oiling jewel bearings in the field was suggested than that of carrying a small bottle of oil which is transferred to the jewel by means of a suitable oiler, perhaps like that one just mentioned. Another suggestion was that the oil be applied to the jewel bearings in the laboratory and carried in suitable containers and the jewel bearings be interchanged in field at the time of test.

The majority of those reporting favored the use of oil having a mineral base while the minority was very emphatically in favor of a fish oil. Both advanced strong arguments for their choice which should be given due consideration.

It is conceded that oil suitable for this purpose should be one which will not turn rancid, evaporate or oxidize when exposed to light and air of varying temperatures. It should possess film forming characteristics and absorption properties to reduce friction at speeds required. It should not corrode, harden or gum after continued use.

Those favoring the use of oil of a mineral base feel that it satisfies most perfectly the aforementioned characteristics and point out that fish or porpoise oil has a serious objection due to its tendency to become rancid after extended use. Those favoring the fish or porpoise oil point out that the watch trade attribute the results of pivot and jewel bearings becoming oxidized and forming an abrasive, thus causing wear on the jewel, to other sources than the property of the oil.

* Report of the Meter Bureau, Technical Section.

They also point out that the fish oil possesses lubricating characteristics far superior to those of an oil of mineral base. This is due to the fact that the petroleum oil has a tendency to spread and thus evaporate, the net result being that in order to obtain the required results more of the mineral oil must be applied than when fish oil is used.

Due to the information which is available, your committee has no definite recommendations to offer relative to the superiority of either oil, but would suggest that the member companies continue the study of this subject in a systematic manner. This would require the setting apart of a certain number of meters operating under varied conditions and a tabulation of the results obtained over a suitable period of time. This would supply concrete facts which are not available at the present time.

High-Tension Metering for Operating Purposes

By W. N. LINDBLAD*

THE scope of this committee was to cover the investigation of the means of reducing the high cost of metering circuits of 15,000 volts and over where the meter record was not to be used in the sale of power but merely for recording an interchange of power between districts, substations or power houses within a company. For the sake of arriving at some basis of necessary accuracy, an arbitrary value of plus or minus 3 per cent was selected as being satisfactory for this class of metering.

Current Transformers

The most obvious method that suggests itself for reducing the current and providing sufficient insulation for such installations is the bushing-type transformer. This transformer is wound on a ring core which is slipped over the high-tension bushing of the power transformer or oil switch. The single lead wire going through the bushing, thus becomes the primary winding of the transformer. A 100,000-volt General Electric bushing transformer was rewound for 100 amp. primary current and tested for ratio and phase angle. A burden of one 5-amp. watthour meter and 40 ft. of No. 10 wire were applied to the secondary.

Results

100 per cent Load: Ratio C.F.= .903 Phase Angle =4 deg. lead 58 min.

10 per cent Load: Ratio C.F.=1.156 Phase Angle =13 deg. lead.

These results show that the ordinary bushing transformer for high voltages and low currents (100 amp.) is entirely impractical for metering purposes.

Brooks Bushing Transformer

The Brooks type of bushing current transformer has been suggested for eliminating some of the inherent errors in bushing transformers. It was not possible to obtain one of these for test, but following are correction values submitted by one of the manufacturers for a 200-amp., 80,000-volt Brooks type bushing transformer:

100 per cent Load: Ratio C.F=1.00 Phase Angle = 0 min.

10 per cent Load: Ratio C.F.=1.00 Phase Angle =100 min.

It is apparent from these results that such a bushing transformer is satisfactory for this class of metering. It requires a special type of watthour meter with double current coils.

The Pacific Electric Manufacturing Company has developed a wound-type current transformer for insertion in the high-voltage circuit of an oil switch or transformer and to be immersed in the oil inside of the transformer or oil switch tank. Its object is to replace the bushing-type current transformer and since it is of the wound type it can be made much more accurate. A 150-amp., 60,000-volt transformer was obtained and tested as follows with one watthour meter burden:

* Report of Meter Bureau, Technical Section.

100 per cent Load: Ratio C.F.=.982 Phase Angle =35 min.

10 per cent Load: Ratio C.F.=.977 Phase Angle =60 min.

The particular transformer tested had been compensated for relay burdens but could readily, by the addition of several turns on the secondary, be compensated so as to be within one-half per cent on ratio error with one watthour meter burden. Where there is room for the installation of this transformer it would be satisfactory for this class of metering.

Potential Transformer

The question of a substitute for the high voltage potential transformer is more difficult than with the current transformers. Several methods have been suggested as: (1) condensers or condenser bushings with a tap taken out to give partial voltage to the meter; (2) a very high resistance in series with a step-up current transformer which would supply potential current to the meter. So far nothing of really practical value has been heard of.

Where the power is transmitted over a 4-wire, 3-phase system and the system is fairly well balanced, a single-phase meter measuring power on one leg only is used by some companies. In this case the degree of accuracy is dependent on the degree of unbalance of the system. In most substations there is usually installed at least one potential transformer per circuit for synchronizing and voltage reading purposes.

In step-up or step-down substations it is often possible to obtain voltage for metering the high-tension circuits on the low-voltage side of the transformers. The accuracy in metering in these cases is dependent on the correctness of the determination of ratio of the transformers and upon their regulation characteristics.

New Development in Electric Meters

By J. H. PAGET*

THE manufacturing companies report the following new meter developments:

Duncan Electric Manufacturing Company

1. Three-wire a.c. meters, 5 to 300 amp. can be furnished with six binding posts, i.e., with the potential leads disconnected from the current coils. This allows the potential of the meter to be connected ahead of the fuses.
2. An improvement has been made in the top bearing pin of all meters, by which cleaning and straightening of the pin is facilitated.
3. A removable guide ring at top of shaft, facilitates cleaning.

Sangamo Electric Company

1. Maximum demand meter with five minute interval.
2. Horizontal polyphase watthour meter with demand attachment.
3. Distant demand dial for ten watthour meters.
4. 6-terminal, 3-wire, S.P. meters.

Westinghouse Electric & Manufacturing Company

1. Type OB watthour meters.
2. Three-element watthour meters with separate elements and one moving element, both house and switchboard types.
3. Complete line of a.c. (type LY) and d.c. (type LX) switchboard instruments with 5½-in. diameter.
4. New line of electric tachometers.

General Electric Company

1. Six-terminal, single-phase, three-wire meters.
2. Type I 14 meters are to have an interior finish, consisting of electrogalvanizing sprayed with a very thin coat of aluminum paint. The front and back plates of the register will be of white metal. The exterior finish will be the usual black. This change is expected to reduce to a minimum any tendency to flake off, due to the much lighter coating, to be more durable, and to facilitate inspection.
3. Temperature compensation for Type I 14 meters. The compensator comprises a small piece of tempera-

* Report of Meter Bureau, Technical Section.

ture sensitive alloy mounted in the magnet shoe. Changes in temperature of the meter result in changes in the permeability of this alloy which, therefore, shunts more or less flux from the active gap of the magnet. Since the temperature characteristics of the ordinary induction meter are not the same on loads of different power factor this compensation will be correct for a given power factor only. Since the bulk of the single phase loads run close to unity power factor a compensator of this kind embraces the average service condition.

4. Changes in Type G demand meter. Several changes have been embodied in the Type G demand meter which will now be known as the G-8. The stylus actuating mechanism is to be equipped with a totalizing register thus providing a means of checking the number of impulses against the watthour meter with which it is coupled.

The double coil armature construction will replace the spring return heretofore standard. The D-3 (3-wire) type of contact will be used. A modification in the armature eliminates any tendency to overshoot on high voltage. An adjustable zero stop insures the sliding pinion always meshing with the intermediate gear when the stylus resets.

5. Contact device. This manufacturer contemplates standardizing on the use of the Type D-3 (3-wire) contact device for all demand meters. This will mean a change to two-coil armature construction sometimes referred to as the electromagnetic armature return. As a result of a careful study of the contact device design, a modified construction has been developed for the principal types of meters. The object has been to minimize friction, simplifying its adjustment and secure maximum reliability. This will be in production at an early date.

6. A complete line of round pattern d.c. and a.c. switchboard instruments 7½ in. in diameter.

Pacific Electric Manufacturing Company

A current transformer to take the place of the ordinary bushing type of current transformer. This transformer is reported to have an accuracy which is practically equal to a modern metering current transformer. O. A. Knopp, one of our members, assisted the manufacturer in designing this transformer.

Member Companies

O. A. Knopp, one of our members, has recently made the following interesting developments:

A multi-range current transformer has been designed with the object of providing a self-calibrating precision standard of a multiplicity of ranges. After calibrating the transformer 1-1 on various burdens it is possible to calibrate, with great precision, current transformers of any range provided for by the standard by using either the Silsbee deflection method or the Silsbee null method.

A multi-range potential transformer which has a utility similar to that of the above described current transformer.

Proper Sizes of Meters for Various Installations

By C. F. GILCRIST*

AN endeavor was made to secure from the various members certain information regarding consumers of the following classes:

1. Any form of industrial plant, either power or lighting service.

2. Heating, or heating and cooking installation, either domestic or commercial.

For each case submitted the following data was requested:

1. Class of service.
2. Kilowatt capacity of utilization apparatus.
3. Kilowatt-hour consumption per year.
4. Highest monthly maximum demand.

Information was received relating to over three hundred installations. These data are listed in the appendix as well as a summary of the results. It will be seen that there is a rather wide variation in some cases from the average value so that it is not possible to apply the figures very closely. On account of the variations in individual installations we feel that it will always be necessary to use considerable judgment in the selection of metering equipment for a specified case. However, there is no question that figures such as collected may be of considerable assistance. Particularly as the information submitted for some of the classes covered so few installations we believe it would be advisable to make a further effort to collect additional information so that a more representative average might be secured.

We wish to thank the following members of the Meter Bureau for their assistance and cooperation in collecting the tabulated information:

W. R. Frampton, Southern California Edison Company.

George H. Searle, Pacific Gas and Electric Company.

R. Crowell, Pacific Gas and Electric Company.

J. C. Abel, Western States Gas & Electric Company, Stockton.

R. S. Daniels, California Oregon Power Company, Medford, Ore.

A. L. Duesbury, Western States Gas & Electric Company, Richmond.

* Report of Meter Bureau, Technical Section.

APPENDIX

Class	No. of installations	Average percentage of maximum demand (15 min.) to installed capacity.	No. of installations whose percentage of maximum demand to installed capacity does not differ from the average by more than 15 per cent.
1—Factories	79	46	18
2—Auto shops	8	40	5
3—Creameries	5	63	..
4—Printing Shops	14	47	6
5—Hotels	9	60	3
6—Warehouses	7	39	2
7—Woodworking plants	31	60	10
8—Packing houses	22	66	10
9—Refrigerating plants	8	86	3
10—Theaters	4	78	1
11—Foundry and machine shops	33	38	10
12—Laundries	7	62	2
13—Stores	13	57	4
14—Telephone plant	1	73	..
15—Office building	11	47	1
16—Quarries	4	61	2
17—Oil refineries	4	68	..
18—Miscellaneous	43	61	14

Installed kw.	Highest kw. demand for year	Demand period in minutes	Kw-hr. per year	Months operated	Demand percentage of installed kw.
		1—Factories			
74.6	40.0	15	5,000	12	54
91.0	82.0	15	3,200	12	90
77.1	49.2	15	6,000	12	64
70.1	13.4	15	400	12	19
447.0	127.0	15	35,000	12	28
873.0	39.5	15	8,900	12	45
33.5	8.2	15	300	12	24
126.5	33.5	15	4,000	12	26
50.0	15.7	15	3,200	12	31
70.9	42.8	15	4,000	12	60
130.7	69.8	15	2,500	12	53
287.0	61.1	15	15,000	12	21
79.0	17.9	15	2,500	12	23
82.0	20.1	15	4,700	12	25
143.0	67.0	15	42,000	12	47
31.3	3.28	15	10	12	10
110.5	61.7	15	33,000	12	56
41.0	31.7	15	9,000	12	77
38.8	22.5	15	11,500	12	58
39.5	1.12	15	10	12	2.8
38.0	11.9	15	2,100	12	31
44.8	28.7	15	8,500	12	64
99.2	29.1	15	6,000	12	29
331.0	159.2	15	20,000	12	48
51.4	24.0	15	6,200	12	47
104.4	26.1	15	4,000	12	25
73.7	21.5	15	2,000	12	29
97.0	28.9	15	4,000	12	30
80.6	44.7	15	4,600	12	45
91.7	29.3	15	4,500	12	32
74.6	25.3	15	500	12	34
83.0	9.48	15	1,300	12	11
141.6	52.9	15	10,000	12	37
606.0	224.0	30	65,000	12	37
138.7	47.7	15	6,500	12	34
55.2	19.0	15	5,000	12	34
331.0	179.0	15	40,000	12	54
80.6	31.3	15	5,400	12	39
161.0	22.4	15	3,000	12	14
55.2	21.4	15	2,300	12	39
55.9	20.1	15	3,500	12	36
40.3	23.8	15	2,400	12	59
184.9	67.0	15	10,000	12	36
685.0	215.0	30	45,000	12	31
186.6	186.0	30	294,780	12	100
159.0	77.0	30	159,840	9	48
55.2	8.0	30	1,110	5	14
339.0	94.0	30	68,920	6	28

Installed kw.	Highest kw. demand for year	Demand period in minutes	Kw-hr. per year	Months operated	Demand percentage of installed kw.
501.0	157.0	30	342,720	12	31
85.0	68.0	30	142,000	12	80
121.5	76.0	30	53,240	12	63
1,176.0	549.0	30	835,200	12	47
968.0	588.0	30	828,240	9	61
94.7	50.0	30	78,750	6	53
77.7	62.0	30	34,200	12	80
133.0	46.0	30	27,040	6	35
376.0	220.0	30	337,600	12	59
113.0	37.5	30	29,100	7	33
414.0	230.0	30	74,220	12	55
54.4	51.0	30	161,424	12	94
130.8	84.0	30	131,820	12	64
85.8	65.0	30	34,080	12	76
113.0	120.0	30	115,440	10	106
74.6	45.0	30	17,070	10	60
117.0	80.0	30	188,140	12	63
174.0	81.0	30	288,180	12	47
1,160.0	1,040.0	30	459,840	12	90
557.0	288.0	30	615,360	11	52
77.6	30.0	30	146,460	12	39
276.0	180.0	15	531,300	12	65
106.8	36.0	15	39,020	12	34
113.0	52.8	15	141,480	12	47
104.0	56.4	15	69,064	12	54
22.8	8.13	15	2,740	12	36
39.2	30.6	15	31,920	12	78
1,433.0	660.0	30	1,121,400	9	46
2,985.0	1,560.0	30	7,645,200	12	52
2,876.0	1,472.0	30	3,643,200	12	51
2,941.0	1,356.0	30	9,314,000	12	46
			2—Auto Shops		
64.8	24.6	15	1,300	12	38
65.0	23.3	15	7,000	12	36
123.0	25.3	15	3,500	12	21
194.0	29.8	15	8,500	12	15
73.2	58.0	15	15,000	12	79
45.3	19.4	15	14,640	12	43
38.8	16.0	15	15,984	12	41
33.2	14.4	15	22,752	12	43
			3—Creameries		
50.7	20.9	15	1,000	12	41
80.5	60.3	15	18,000	12	75
62.7	32.8	15	5,500	12	52
139.8	83.0	15	25,000	12	59
78.3	68.0	15	147,040	12	87
			4—Printing shops		
70.1	23.0	15	1,500	12	33
100.0	53.0	15	7,500	12	53
68.6	35.8	15	5,000	12	52
52.2	18.6	15	2,600	12	30
478.0	236.0	15	40,000	12	49
722.0	179.0	30	70,000	12	25
83.6	8.93	15	2,000	12	11
51.4	42.5	15	5,000	12	83
104.4	52.2	15	10,000	12	50
140.3	63.6	15	10,000	12	45
58.6	45.1	15	5,600	12	77
20.5	9.0	15	7,000	12	44
176.2	57.7	15	131,400	12	33
175.4	122.4	15	101,280	12	70
			5—Hotels		
31.3	12.1	15	1,150	12	39
12.7	14.9	15	2,100	12	117
117.0	50.7	15	12,210	12	43
28.4	20.5	15	11,000	12	72
17.2	8.94	15	4,000	12	52
170.0	60.3	15	25,000	12	35
313.0	135.6	15	80,000	12	43
69.8	48.0	15	136,500	12	69
54.1	36.9	15	100,496	12	68
			6—Warehouses		
26.1	10.7	15	1,750	12	41
45.5	17.9	15	4,240	12	39
28.3	18.3	15	2,000	12	65
82.7	16.4	15	4,500	12	20
28.0	3.84	15	1,760	12	14
20.9	3.0	15	3,720	12	14
70.6	54.0	15	158,000	12	77
			7—Woodworking plants		
68.7	28.6	15	3,000	12	42
73.1	55.9	15	5,500	12	76
56.0	39.3	15	6,500	12	70
77.7	79.9	15	5,000	12	103
59.7	61.4	15	7,000	12	103
163.0	64.7	15	9,500	12	40
75.3	32.2	15	4,500	12	43
33.6	20.9	15	1,400	12	62
74.6	16.8	15	1,700	12	23
222.0	86.3	15	12,000	12	39
122.4	52.2	15	8,000	12	43
1,180.0	552.0	30	1,232,400	12	47
553.0	306.0	30	546,600	12	55
194.0	36.0	30	3,790	8	19
84.3	33.0	30	26,100	9	39
43.3	51.0	30	119,520	9	118
163.6	73.0	30	43,280	8	45
399.0	192.0	30	303,360	12	48
85.0	59.0	30	3,380	12	69
81.2	22.0	30	25,290	12	27
591.0	370.0	30	674,400	12	63
356.0	135.0	15	98,240	12	38
122.6	77.8	15	69,360	12	63
44.4	27.8	15	26,540	12	63
174.0	120.0	15	153,180	12	69
408.0	218.0	15	316,040	12	53
25.0	19.2	15	18,016	12	77
39.5	43.1	15	34,050	12	109
605.0	444.0	15	893,560	12	73
480.0	312.0	15	584,030	12	65
570.0	368.0	15	743,920	11	65
			8—Packing houses		
48.5	32.2	15	14,000	12	66
42.5	23.8	15	7,900	12	56
109.0	47.0	15	6,600	12	43
224.0	82.2	15	9,000	12	37
73.1	26.3	15	7,000	12	36
67.0	29.8	15	13,000	12	44
176.0	104.0	30	261,600	12	59
145.0	108.0	30	284,880	12	74
166.0	89.0	30	170,400	8	54
317.0	136.0	30	250,480	10	43
66.3	55.0	15	60,864	12	83
448.0	252.0	15	265,340	12	56
126.0	77.7	15	70,200	12	62
26.1	31.4	15	9,504	12	120
112.0	69.8	15	52,860	12	62
37.2	19.2	15	8,520	12	52
44.0	36.8	15	32,440	12	84
119.0	90.0	15	48,360	12	76
39.5	39.2	15	11,680	12	99
147.0	68.0	15	90,840	12	46
69.2	102.0	15	89,520	12	148
94.7	56.0	15	49,520	12	59
			9—Refrigerating plants		
78.3	43.9	15	13,000	12	56
54.1	61.0	30	284,352	12	113
769.0	745.0	15	3,970,400	12	97
14.6	20.0	15	16,800	12	137
53.7	50.3	15	74,580	12	94
322.0	238.5	15	1,122,000	12	74
20.4	11.5	15	47,640	12	56
96.6	60.6	15	283,380	12	63
			10—Theaters		
167.3	44.6	15	6,100	12	27
32.8	39.2	15	13,344	12	119
29.6	28.15	15	90,024	12	95
40.6	28.8	15	90,936	12	71
			11—Foundry and machine shops		
152.0	40.6	15	5,000	12	27
424.0	67.0	15	11,000	12	16
53.0	12.4	15	3,000	12	23
42.5	14.9	15	3,200	12	35
101.0	12.2	15	1,500	12	12
69.2	34.6	15	7,000	12	50
53.7	15.9	15	2,800	12	30
140.3	52.1	15	10,000	12	37
97.0	38.0	15	5,000	12	39
78.3	33.8	15	5,000	12	43
37.2	27.7	15	3,500	12	74
39.5	2.61	15	200	12	6.6
44.0	10.7	15	1,000	12	24
71.6	13.4	15	1,000	12	19
176.0	50.1	15	2,700	12	28
82.0	27.7	15	6,000	12	34
44.8	9.1	15	1,100	12	20
216.0	25.1	15	3,500	12	12
25.4	6.41	15	3,200	12	25
43.3	12.1	15	1,800	12	28
276.0	116.0	15	17,000	12	42
129.0	31.0	30	40,368	12	24
133.5	72.0	30	80,880	10	54
618.0	200.0	30	313,400	7	32
215.0	62.0	30	52,560	9	29
170.0	56.0	30	58,710	10	33
107.0	43.5	30	70,560	12	41
41.0	63.0	30	49,980	12	154
85.8	57.0	30	5,820	4	66
109.6	52.0	30	38,120	12	47
55.6	31.9	15	22,460	12	57
67.8	19.95	15	8,100	12	29
76.3	30.8	15	35,520	12	40
			12—Laundries		
50.7	33.5	15	8,000	12	66
87.2	39.1	15	9,500	12	45
96.3	55.6	15	12,000	12	58
147.0	60.2	15	10,000	12	41
50.0	36.5	15	12,000	12	73
51.1	38.9	15	62,840	12	76
28.5	21.7	15	36,576	12	76
			13—Stores		
630.0	112.0	15	35,000	12	18
911.5	377.0	15	10,000	12	41
71.6	23.1	15	15,000	12	32
80.6	26.1	15	3,400	12	32
42.8	48.0	15	34,640	12	112
76.8	42.8	15	67,632	12	56
69.9	36.1	15	87,980	12	52
34.9	23.9	15	120,620	12	68
33.1	33.7	15	131,552	12	102
23.9	13.6	15	15,264	12	57
30.1	21.5	15	34,048	12	71
110.4	52.4	15	126,000	12	47
28.6	14.55	15	56,936	12	51
			14—Telephone plant		
40.5	29.5	15	69,900	12	73
			15—Office buildings		
53.0	7.97	15	1,800	12	15
21.6	20.3	15	1,300	12	94
34.3	17.1	15	4,250	12	50
38.1	13.4	15	3,500	12	35
64.2	21.1	15	5,000	12	33
129.0	90.6	15	21,000	12	70

Installed kw.	Highest kw. demand for year	Demand period in minutes	Kw-hr. per year	Months operated	Demand percentage of installed kw.
85.0	20.8	15	7,000	12	24
124.6	45.5	15	15,000	12	36
63.0	21.0	15	42,270	12	33
83.3	29.3	15	86,424	12	35
54.7	51.0	15	41,206	12	93
			16—Quarries		
93.3	38.7	15	6,000	12	41
220.0	177.0	30	181,440	12	80
138.0	84.0	30	196,480	12	61
382.0	237.0	15	779,840	12	62
			17—Oil refineries		
116.5	110.0	30	41,360	11	94
53.7	45.0	30	45,560	12	84
261.0	128.0	30	60,160	11	49
1,724.0	740.0	30	2,516,000	12	43
			18—Miscellaneous		
54.4	5.96	15	400	12	11
201.0	9.7	15	1,500	12	4.8
50.0	23.8	15	6,000	12	48
97.7	23.9	15	3,000	12	25
339.0	206.0	15	40,000	12	61
76.4	51.7	15	20,000	12	68
158.0	89.4	15	15,000	12	57
205.0	111.8	15	18,500	12	54
21.6	15.7	15	2,500	12	73
38.8	10.6	15	3,000	12	27
78.0	54.3	15	5,200	12	70
59.6	20.8	15	2,500	12	35
82.0	26.1	15	1,000	12	32
123.2	16.4	15	1,700	12	13
35.1	1.57	15	150	12	4.5
6.71	15.7	15	1,700	12	224
38.1	9.46	15	3,000	12	25
225.0	61.8	15	12,000	12	27
455.0	106.0	15	385,280	12	23
235.0	60.0	15	219,600	12	25
370.0	250.0	15	489,360	12	67
373.0	326.0	15	526,080	12	87
116.0	76.0	15	59,600	12	66
160.0	93.0	15	703,520	12	58
1,320.0	710.0	15	2,582,400	12	54
117.6	66.0	30	60,480	5	56
52.2	56.0	30	107,640	12	104
63.4	54.0	30	29,460	12	85
28.4	30.0	30	5,550	12	103
89.6	110.0	30	115,720	12	123
164.0	112.0	30	198,960	12	68
102.3	76.0	33	34,520	8	74
70.1	30.0	30	25,160	12	43
48.1	37.0	15	39,920	12	77
23.9	17.3	15	14,200	12	72
40.6	19.2	15	82,128	12	47
37.7	25.55	15	83,984	12	68
26.1	42.0	15	12,240	12	161
15.3	10.5	15	5,012	12	69
74.6	51.9	15	21,240	12	70
24.4	11.2	15	2,160	12	46
34.3	16.5	15	9,210	12	45
436.0	192.0	15	488,880	12	44
205.0	34.9	15	5,000	12	17
31.9	22.1	15	9,160	9	69
77.6	38.3	15	31,856	12	49

Effect of Wave Shape on Time-Current Characteristics of Time Relays

Report of Committee on Maintenance of Relays, Meter Bureau*

THE purpose of these tests is to determine the effect of different types of loading devices on the time-current characteristics of induction relays and, if possible, adopt a standard method of loading comparable to service conditions.

Three types of induction relays were tested under as near the same conditions as possible. Each relay was tested on two current taps and points taken from 200 per cent to 1,000 per cent of these settings. Three checks were taken at each point and the average used.

Four different methods of loading were employed, as follows:

(1) General Electric meter loading rheostats practically non-inductive.

(2) States company's phantom load, consisting of a low-voltage, constant-potential transformer loaded by resistance on the secondary (low-voltage) side, known as phantom load "A."

(3) A low-voltage, constant-potential transformer controlled on the primary side by adjustable resistance, known as phantom load "B."

(4) A General Electric Type M.I.R.S. induction regulator, ratio primary 110/220, secondary 11/22 volts.

* J. C. Alberts, Los Angeles Bureau of Power and Light, chairman; A. R. Arnold, Southern California Edison Company; J. C. Abbott, Southern California Edison Company; L. S. Conrad, Southern California Edison Company; E. A. Russell, Southern California Edison Company.

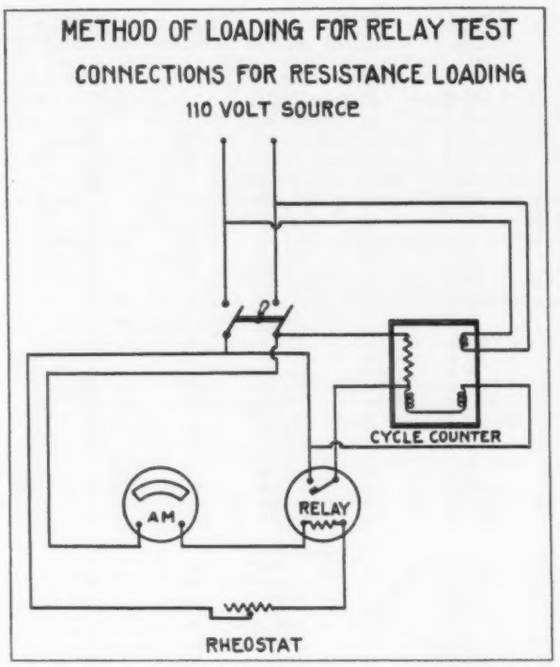

Fig. 1

Diagrams of connections are shown in Figs. 1, 2, 3, 4. A Westinghouse cycle counter was used to determine time.

Relays used were:

Westinghouse type CO standard, 4-12 amperes, 50 cycles.

Westinghouse type CO (low-energy), 4-12 amperes, 50 cycles.

General Electric type IA-101, 4-10 amperes, 50 cycles.

The results of these tests showing the time-current characteristics of induction relays as shown by different test methods are shown in Tables I to VI, inclusive, and in Figs. 5 to 9, inclusive.

Table No. VII is a summary tabulation showing average, maximum and minimum differences for all relays and all methods of loading.

Tables I and II give, in addition to the four methods

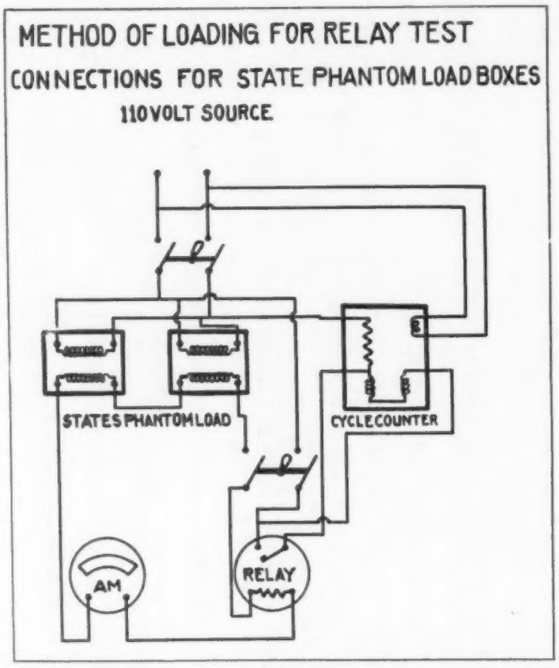

Fig. 2

TABLE I

Relay: W. E. & Mfg. Co. type, CO standard, Serial No. 452371, 4/12 amp., definite minimum time 4 sec., Style No. 500052.
Ammeter: W. E. & Mfg. Co. Style 169514-C, Serial No. 296440, 20/40 amp.
Cycle counter: W. E. & Mfg. Co. Style No. 237124-A, Serial No. 395878.
Loading devices: G. E. meter testing rheostats.
Phantom Load "A"—States Co., #1152-1153.
Phantom load "B"—110/12-volt transformer controlled by primary resistance.
G. E. type M. I. R. S., induction regulator #3955853, 110/11 volts.

Relay data				Resistance Loading Fig. 1 Oscillogram #138	Phantom load "A" Fig. 2 Oscillogram #141	Phantom load "B" Fig. 3 Oscillogram #144	Induction regulator Fig. 4 Oscillogram #158	Inverted current Transformer* Oscillogram #149
Amp. tap	Percent load	Time index setting	Time from curve—in cycles	Time in cycles	Time in cycles	Time in cycles	Time in cycles	Time in cycles
4	200	5	129	130	130	138	133	130
4	300	5	95	100	105	110	104	102
4	400	5	86	88	95	100	94	89
4	500	5	84	85	92	95	88	82
4	600	5	80	80	87	95	85	77
4	700	5	77	78	87	95	83	75
4	800	5	76	76	86	..	83	75
4	900	5	74	75	85	..	83	73
4	1,000	5	74	75	85	..	82	74

*Westinghouse 10/5-amp. current transformer used inverted as phantom load with resistance control in primary connected as in Fig. 3.

TABLE II

Relay: W. E. & Mfg. Co. type CO standard, Serial No. 452371, 4/12 amp., definite minimum time 4 sec., Style No. 500052.
Ammeters: W. E. & Mfg. Co., Style No. 169514-C, Serial No. 296440, 20/40 amp.
Style No. 169517-C, Serial No. 274231, 60/120 amp.
Cycle counter: W. E. & Mfg. Co. Style No. 237124, Serial No. 395878
Loading devices: G. E. meter testing rheostats.
Phantom load "A"—States Co., #1152-1153.
Phantom load "B"—110/12-volt transformer controlled by primary resistance.
G. E. type M. I. R. S. induction regulator, 110/220 to 11/22 volts, sec. amp. 50.

Relay data				Resistance Loading Fig. 1 Oscillogram*	Phantom load "A" Fig. 2 Oscillogram*	Phantom load "B" Fig. 3 Oscillogram #17	Induction regulator Fig. 4 Oscillogram #159	Inverted current Transformer Oscillogram†
Amp. tap	Percent load	Time index setting	Time from curve—in cycles	Time in cycles	Time in cycles	Time in cycles	Time in cycles	Time in cycles
10	200	5	129	140	140	150	143	130
10	300	5	95	107	110	120	111	100
10	400	5	86	95	103	110	100	90
10	500	5	84	93	100	110	94	84
10	600	5	80	90	98	110	..	82
10	700	5	77	90	98	108	..	..
10	800	5	76	88	98	105	..	..
10	900	5	74	88	97	102	..	..
10	1,000	5	74	88	98	110	..	..

*No oscillograms taken on resistance and phantom load "A" because they were very nearly the same as on the 4-amp. tap of same relay.
†Westinghouse 10/5-amp. current transformers used inverted as phantom load with resistance control in primary, connected as in Fig. 3.

TABLE III

Relay: W. E. & Mfg. Co., type CO, low energy, Serial No. 581220, 4/12 amp., definite minimum time 2 sec., style No. 328860-A.
Ammeter: W. E. & Mfg. Co., Style No. 169514-C, Serial No. 296444, 20/40 amp.
Cycle counter: W. E. & Mfg. Co., Style No. 237124-A, Serial No. 395878.
Loading devices: G. E. meter testing rheostats.
Phantom load "A"—States Co., #1152-1153.
Phantom load "B"—110/12-volt transformer controlled by primary resistance.
G. E. type M. I. R. S. induction regulator, 110/220 to 11/22 volts, sec. amp. 50.

Relay data				Resistance loading Fig. 1 Oscillogram #139	Phantom load "A" Fig. 2 Oscillogram #142	Phantom load "B" Fig. 3 Oscillogram #145	Induction regulator Fig. 4 Oscillogram #157
Amp. tap	Percent load	Time index setting	Time from curve—in cycles	Time in cycles	Time in cycles	Time in cycles	Time in cycles
4	200	10	825	900	902	915	890
4	300	10	425	425	412	425	418
4	400	10	285	280	275	280	274
4	500	10	210	220	219	225	218
4	600	10	190	196	188	195	190
4	700	10	160	170	170	175	171
4	800	10	150	155	158	160	159
4	900	10	142	145	145	150	150
4	1,000	10	137	139	140	145	141

TABLE IV

Relay: W. E. & Mfg. Co. type CO, low energy, Style No. 328860-A, 4/12 amp., 50 cycles, definite minimum time, 2 sec., Serial No. 581220.
Ammeter: W. E. & Mfg. Co., Style No. 169517-C, Serial No. 274231, 60/120 amp.
Cycle counter: W. E. & Mfg. Co., Style No. 237124-A, Serial No. 395878.
Loading devices: G. E. meter testing rheostats.
Phantom load "A"—States Co., #1152-1153.
Phantom load "B"—110/12-volt transformer controlled by primary resistance.
G. E. type M. I. R. S. induction regulator, 110/220 to 11/22 volts, sec. amp. 50.

Relay data		Time index setting	Time from curve—in cycles	Resistance loading Fig. 1 Oscillogram*	Phantom load "A" Fig. 2 Oscillogram*	Phantom load "B" Fig. 3 Oscillogram*	Induction regulator Fig. 4 Oscillogram #156
Amp. tap	Percent load			Time in cycles	Time in cycles	Time in cycles	Time in cycles
10	200	10	825	867	851	860	827
10	300	10	425	406	395	415	397
10	400	10	285	270	265	273	262
10	500	10	210	220	210	218	210
10	600	10	190	185	182	185	...
10	700	10	160	168	162	170	...
10	800	10	150	155	150	155	...
10	900	10	142	145	140	145	...
10	1,000	10	137	136	135	137	...

*No oscillograms taken on resistance, or phantom loads "A" and "B" because there was the same general wave shape as on 4-amp. tap of this relay.

TABLE V

Relay: G. E. type IA-101, Style No. 174680763, 4/10 amp., 50 cycles, definite minimum time 3 sec., Serial No. 253591.
Ammeter: W. E. & Mfg. Co. Style No. 169514-C, Serial No. 296444, 20/40 amp.
Cycle counter: W. E. & Mfg. Co. Style No. 237124-A, Serial No. 395878
Loading devices: G. E. meter testing rheostats.
Phantom load "A"—States Co. #1152-1153.
Phantom load "B"—110/12-volt transformer controlled by primary resistance.
G. E. type M. I. R. S., induction regulator, 110/220 to 11/22 volts, sec. amp. 50.

Relay data		Time index setting	Time from curve—in cycles	Resistance loading Fig. 1 Oscillogram #140	Phantom load "A" Fig. 2 Oscillogram #143	Phantom load "B" Fig. 3 Oscillogram #146	Induction regulator Fig. 4 Oscillogram #161
Amp. tap	Percent load			Time in cycles	Time in cycles	Time in cycles	Time in cycles
4	200	10	450	480	460	480	476
4	300	10	295	300	310	320	330
4	400	10	250	250	250	262	267
4	500	10	205	210	220	235	233
4	600	10	194	191	198	210	211
4	700	10	183	175	185	196	194
4	800	10	172	165	175	185	183
4	900	10	161	162	167	176	171
4	1,000	10	150	150	160	171	163

TABLE VI

Relay: G. E. type IA-101, Style No. 174680763, 4/10 amp., 50 cycle., definite minimum time 3 sec., Serial No. 253591
Ammeters: W. E. & Mfg. Co. Style No. 169514-C, Serial No. 296444, 20/40 amp.
Style No. 169517-C, Serial No. 274231, 60/120 amp.
Cycle counter: W. E. & Mfg. Co. Style No. 237124-A, Serial No. 395878.
Loading devices: G. E. meter testing rheostats.
Phantom load "A"—States Co., #1152-1153.
Phantom load "B"—110/12-volt transformer controlled by primary resistance.
G. E. type, M. I. R. S., induction regulator, 110/220 to 11/22 volts, sec. amp. 50.

Relay data		Time index setting	Time from curve—in cycles	Resistance loading Fig. 1 Oscillogram*	Phantom load "A" Fig. 2 Oscillogram*	Phantom load "B" Fig. 3 Oscillogram*	Induction regulator Fig. 4 Oscillogram #160
Amp. tap	Percent load			Time in cycles	Time in cycles	Time in cycles	Time in cycles
10	200	10	450	455	467	490	455
10	300	10	295	311	325	313	312
10	400	10	250	257	255	260	253
10	500	10	205	220	226	220	220
10	600	10	194	204	205	205	...
10	700	10	183	190	192	192	...
10	800	10	172	177	180	182	...
10	900	10	161	170	172	173	...
10	1,000	10	150	163	158	...	...

*No oscillograms taken on resistance or phantom loads "A" and "B" as they are the same general shape as those on the 4-amp. tap of this relay.

TABLE VII

RELAY		W. E. & Mfg. Co. CO Relay—Standard			W. E. & Mfg. Co. CO Relay—Low energy			General Electric Co.—IA-101 Relay		
Amp. tap	Time index setting	Ave. % error	Max. % error	Min. % error	Ave. % error	Max. % error	Min. % error	Ave. % error	Max. % error	Min. % error
Resistance Loading*										
4	5–10–10	− 1.5	− 5.3	0	−3.2	− 9.1	0	−0.2	− 6.6	0
10	5–10–10	−13.9	−18.8	− 8.5	−0.8	+ 5.2	+0.7	−4.7	− 8.6	−1.1
Phantom load "A"										
4	5–10–10	−10.6	−14.8	− 0.8	−2.4	− 9.3	+1.0	−3.3	− 7.3	0
10	5–10–10	−22.8	−32.4	− 8.5	+1.8	+ 7.0	0	−5.9	−10.2	−2.0
Phantom load "B"										
4	5–10–10	−15.9	−23.4	− 7.0	−5.1	−10.9	0	−8.9	−14.6	−6.6
10	5–10–10	−33.7	−48.5	−16.3	−1.2	− 6.2	0	−5.5	− 8.9	−4.0
Induction regulator										
4	5–10–10	− 6.1	−12.2	+ 1.9	−3.1	− 7.9	0	−8.4	−13.5	−5.8
10	5–10–10	− 9.0	−11.9	− 4.7	+4.9	+ 8.1	0	−4.4	− 7.3	−1.1
Inverted 10/5 amp. current transformer										
4	5	+ 1.9	+ 3.7	− 0.7						
10	5	+ 0.9	+ 5.6	− 0.8						

*Errors shown on resistance loading are not due to method of testing but rather to the relay adjustment.

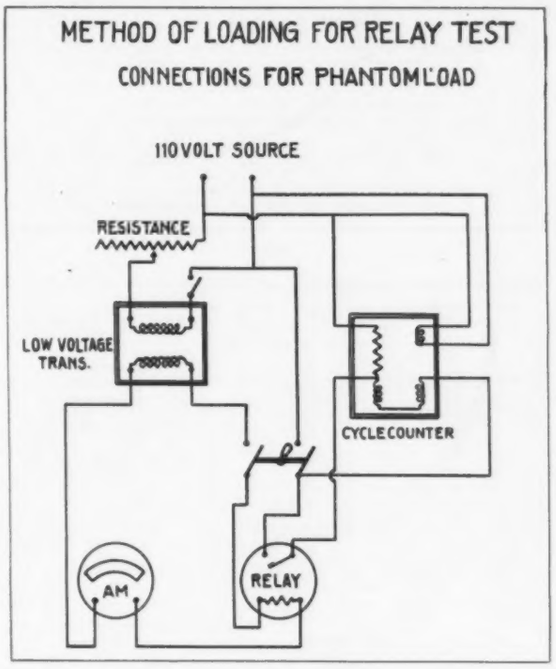

Fig. 3

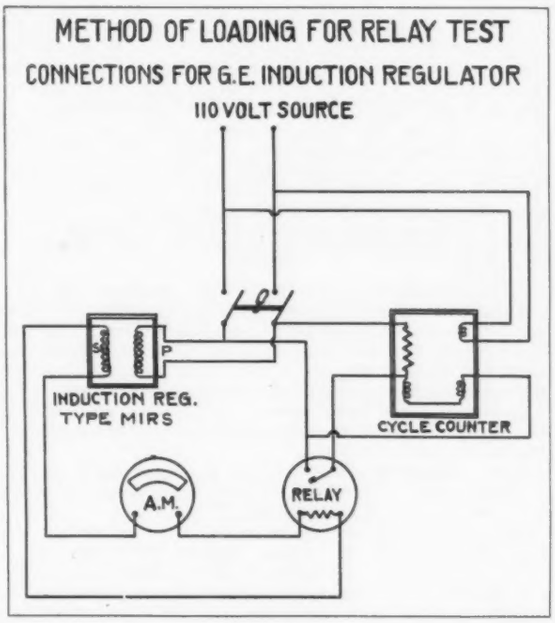

Fig. 4

of loading explained above, the results obtained by using an inverted current transformer of ratio 10 to 5.

This method was tried only on the standard CO relay since it was found that this relay was more susceptible to change of wave shape than the others.

Oscillograms of current through and voltage across the relay were taken to show the effects of the different loading devices on wave shape.

It is seen by examination of these tables that in nearly every case resistance loading gives the shorter time interval, the error varying from 0 to 30 per cent depending on the type of loading, percentage load and type of relay, the greatest difference being on the standard type CO relay between resistance loading and

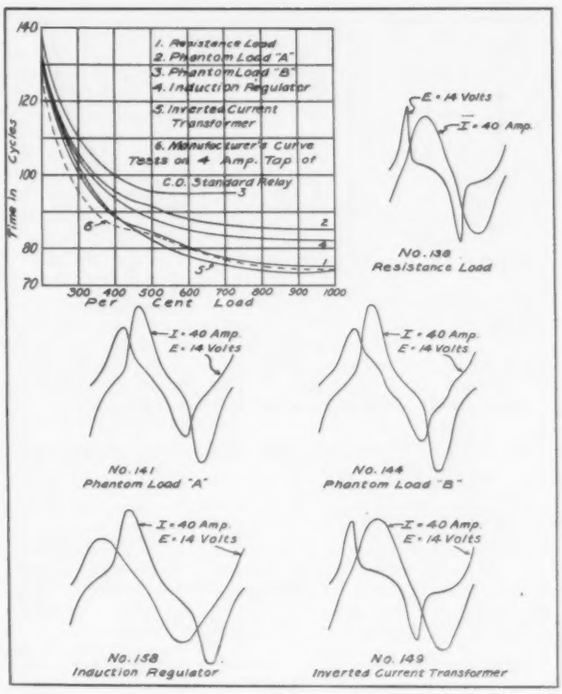
1. Resistance Load
2. Phantom Load "A"
3. Phantom Load "B"
4. Induction Regulator
5. Inverted Current Transformer
6. Manufacturer's Curve Tests on 4 Amp. Tap of C.O. Standard Relay
Time in Cycles
Per Cent Load
E = 14 Volts
I = 40 Amp.
No. 138 Resistance Load
No. 141 Phantom Load "A"
No. 144 Phantom Load "B"
No. 158 Induction Regulator
No. 149 Inverted Current Transformer

Fig. 5

phantom load "B" at 1,000 per cent in which case it amounts to 30 per cent. The difference in time at 200 per cent load between the above methods of loading was only 8 per cent. Phantom load "A" gave results about half-way between these extremes. Results obtained by using the inductive regulator were closer to the results as obtained by resistance than those obtained by use of either phantom loads. The least affected relay was the type CO, low-energy relay, which shows very little difference in time-current characteristics between resistance load and that obtained from phantom load "A," but shows a maximum difference of about 5 per cent between the resistance load and the phantom load "B."

The General Electric type IA-101 relay is affected slightly more than the low-energy type CO, so far as

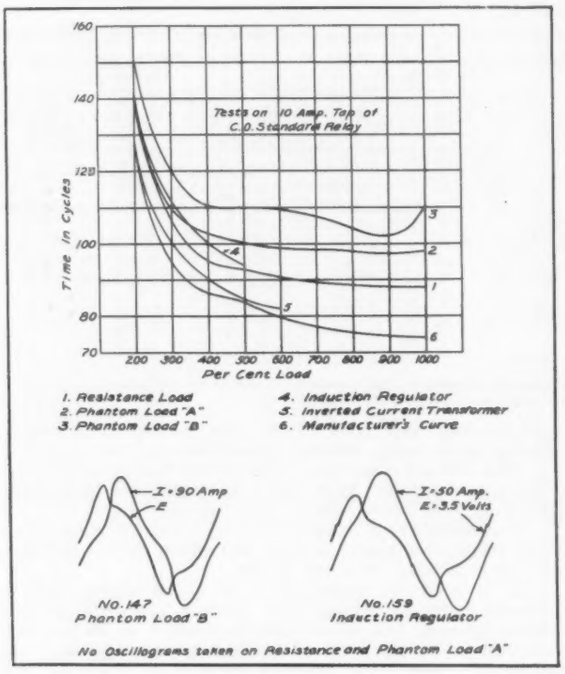

Fig. 6

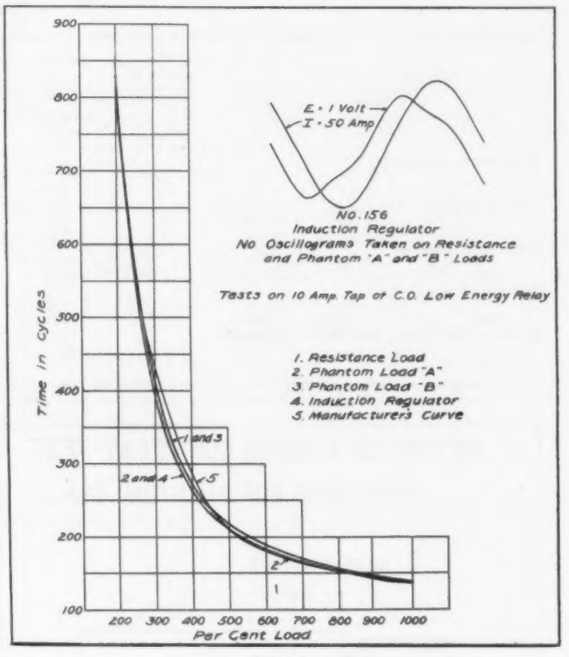
E = 1 Volt
I = 50 Amp
No. 156
Induction Regulator
No Oscillograms Taken on Resistance and Phantom "A" and "B" Loads
Tests on 10 Amp. Tap of C.O. Low Energy Relay
1. Resistance Load
2. Phantom Load "A"
3. Phantom Load "B"
4. Induction Regulator
5. Manufacturer's Curve
Time in Cycles
Per Cent Load

Fig. 8

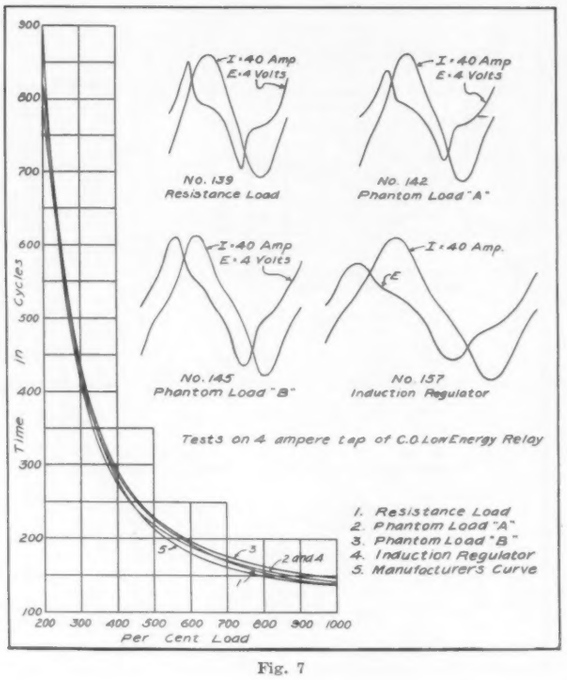

Fig. 7

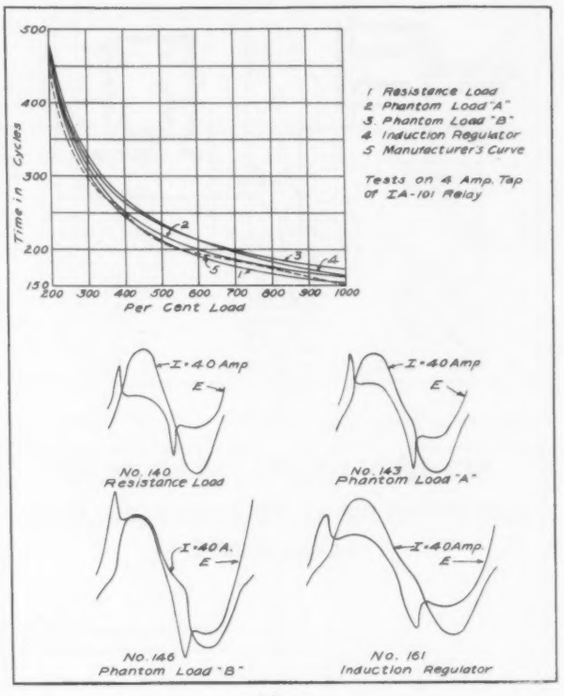

Fig. 9

differences in time caused by different methods of loading for purposes of calibration are concerned. The large discrepancy between the curve as supplied by the manufacturer and that obtained on resistance load in this relay was caused by a change of position of the relay contacts by ourselves, and it should not be assumed that this relay left the factory in that condition.

The oscillograms all show that with resistance loading the current in the relay is a sine curve, as would be expected. The voltage across the relay is distorted by the saturation of the iron parts of the relay. This saturation is necessary in order to make the relay come to a final definite time.

When loading a relay by resistance connected across 110 volts or higher, the drop in voltage across the relay is small compared to the total so that the distortion of supply voltage due to the relay coils is small, and as a result, the current through the relay and resistance combined is very nearly sinusoidal. When, however, the drop across the relay is a large percentage of the total impressed voltage, as it is when using a low voltage transformer, the E.M.F. of the circuit is no longer a sine wave, but is distorted by the saturated iron of the relay magnetic circuit which in turn causes a distorted current wave.

Since magnetic flux is directly dependent on the current the flux is correspondingly distorted, causing a decrease of torque on the disc.

An ammeter connected in series with the relay reads effective amperes, or square root of the mean square of the wave. The square root of the mean squares for the peaked wave may be equal to the square root of the mean square of the sine wave, and thus read the same on the ammeter, but their reactions on the current in-

duced in the rotating disc (torque) may be quite different.

This current distortion is increased by using resistance control in the primary of the loading transformer, since in this case the exciting current of the transformer is influenced by the resistance and the secondary voltage can not be sinusoidal. This further distorts the current in the relay, as is shown by the oscillograms as taken on the relays when loaded by phantom load "B."

From these tests we believe it is conclusively shown that apparatus used for relay calibration should be of such a nature as to give a sine wave current in the relay when it is connected in the circuit for calibration, in order that consistent calibration may be obtained.

As to the shape of the current wave passing through the relay at the time of tripping in service, that is problematic and a question open for discussion.

In making the above tests it was found that the relays became very hot during the course of the test. It therefore was thought that the effect of temperature should be investigated. Numerous tests were made on several relays at extreme temperatures. It was found that a hot relay was slower than a cold one, the error being rather large.

The above results thus may have some temperature errors, as no effort was made to correct them. As all the tests on any one relay were made on different days and in the same manner regarding starting at 200 per cent load and increasing the load to 1,000 per cent, the results should be comparable as the temperature at any particular load on any particular relay would be about the same.

Safety Rules

Report of Safety Rules Bureau, Technical Section*

THERE were three meetings held during the year, the first at Los Angeles, Sept. 19, 1924, the second at San Francisco, Jan. 9, 1925, and the final meeting March 27, 1925, at Fresno.

At the first meeting it was decided to put forth every effort possible to assist those in charge of the printing and revision of the State Safety Code. By appointing Mr. Kimball as a member of our bureau, we were enabled to keep in close touch with the work being done, and are pleased to state that the Electrical Safety Orders are now being published in tentative form and will be distributed as soon as possible after the public hearings, held May 12 and 19.

The subject of test facilities and industrial switches was given considerable time and thought, a report being submitted by R. H. Cates. It was agreed that the installation of test devices on light and power installations, to permit testing service meters and motors on consumers' premises without undue hazard to the tester was made necessary with the adoption of the state Safety Code, as all electrical wiring and control apparatus is required to be totally enclosed in metal conduits, cabinets, or race ways, all of which are required to be permanently grounded.

The manufacturers cooperated with the bureau in every way possible and submitted a large number of various types of switches and test facilities for the approval of the members, and by attending the meeting, the manufacturers' representatives were enabled to become familiar with the desires of those interested in this subject.

Before the first meeting of the bureau it was suggested by some of the members of the commercial section of the P.C.E.A. that the subject of electric range and heater installations be taken up with the idea of arriving at some suggestion as to changes to be made in the National Electric Code whereby the expense of electric range and heater installations could be reduced without materially reducing the safety features. J. M. Buswell carried on an investigation and submitted a final report at the Fresno meeting. While space will not permit of publishing the report, a number of suggestions were made which is of interest to all concerned. Parts of the code involved seem to be as follows: Article 16, Section 1602-C and 1602-D. Article 8, Section 811. There may be other sections where changes should be made but these are the principal ones.

The report gives full details as to recommendations and it is suggested that it be presented for approval by the Technical Section and forwarded as follows: A—To the Commercial Section, P.C.E.A., as a response to that section's request for a report on the subject. B—By the Technical Section Executive Committee to the National Electric Light Association, Industrial Accident Commission of California, the California Association of Electrical Inspectors and the commercial managers of member companies of the association. This should be done in an effort to bring about the suggested modifications.

In a report submitted by E. J. Crawford, a member of this bureau, at a meeting held in San Francisco by the Association of Electrical Inspectors, it was stated that Mr. Mitchell gave an outline of a number of changes which will appear in the 1925 Code. However, it was not stated what the changes were or that they have any connection with the above subject.

Because the National Electrical Code is in process of revision and the Electrical Safety Orders practically ready for public hearing, the subject of grounding circuits on consumers' installations was considered and the report was submitted by N. B. Hinson. Some very interesting results were obtained by tests made with the use of conduit for grounding purposes. This is being carried out by the Southern California Edison Company.

From the study of results obtained it is seen that the conduit is a better ground conductor than the copper wire and that the worst condition is the one required by the Code and ordinarily used, that is No. 8 insulated wire in ½-in. conduit with the wire carrying all the current.

It was also noted that in case of very heavy ground current the value at which the conduit would be destroyed by heating due to the current is several times that required to fuse copper. Approximately 475 amp. will fuse the No. 8 copper, while 1,500 amp. applied for fifteen minutes raised ½-in. conduit to red heat but did not damage it.

At the suggestion of the bureau there was appointed from each power company in California a representative as a member of the California Association of Electrical Inspectors, thus giving the association the support of the utilities and at the same time keeping in touch with changes of rules, etc., which may be proposed from time to time.

The following subjects were proposed for the work of the Safety Rules Bureau for the ensuing year: A—Safety orders application of, (keeping in mind that of providing test facilities). B—National Electric Code—to secure copies of tentative changes and outline suggested changes, tying in with the state Association of Inspectors through the representatives of this bureau who are members of that association. C—Grounding problems and requirements on consumers' installations. D—Safety switches, tying in with the meter committee of this section.

* W. H. Talbott, San Diego Consolidated Gas & Electric Company, chairman; J. E. Brown, Westinghouse Electric & Manufacturing Company; J. M. Buswell, San Joaquin Light & Power Corporation; R. H. Cates, Southern California Edison Company; E. N. D'Oyly, Western States Gas & Electric Company; W. R. Frampton, Southern California Edison Company; N. B. Hinson, Southern California Edison Company; J. A. Koontz, Jr., Great Western Power Company; S. J. Lisberger, Pacific Gas and Electric Company; H. H. Miller, Southern Sierras Power Company; E. R. Northmore, Los Angeles Gas & Electric Corporation; S. P. Russell, H. B. Squires Company; D. D. Smalley, Midland Counties Public Service Corporation.

Duct Line Temperature Measurement

By RAYMOND LEWELLING*

THE measurement of temperatures in underground conduits is being given considerable attention this year. The study of temperature conditions is necessary for determining the best economy of underground cable distribution practice.

A system of temperature measurement is being installed in a high-voltage conduit line by the Los Angeles Bureau of Power and Light, of which the following is a brief description:

By the use of a temperature bridge for measuring the resistance change in a unit length of No. 20 B&S gage copper wire accurately calibrated for temperature change, it is possible to study temperatures at remote

* Report of Underground Systems Bureau, Technical Section.

points in an underground conduit with a very high degree of accuracy. The distance from the instrument at which the temperature unit may be placed depends upon the uniformity in resistance of the two wires connecting

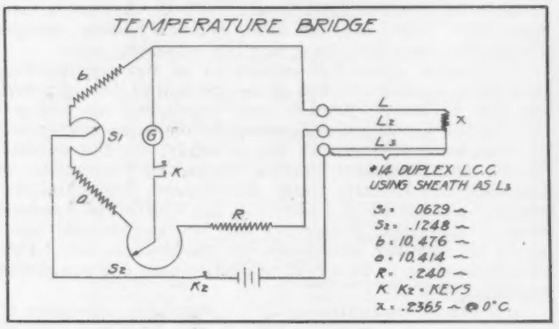

Fig. 1

the same. Using No. 14 B&S gage wire will allow of a distance of 50 ft. with an accuracy of within 1 deg. C.

For the study of temperatures in new conduit construction the temperature unit and wires are placed in the concrete of the conduit and become a part thereof (see Fig. 1) the ends of the wires being taken into a nearby manhole. The calibrated copper unit being very small, it is possible to place it under the lead covering

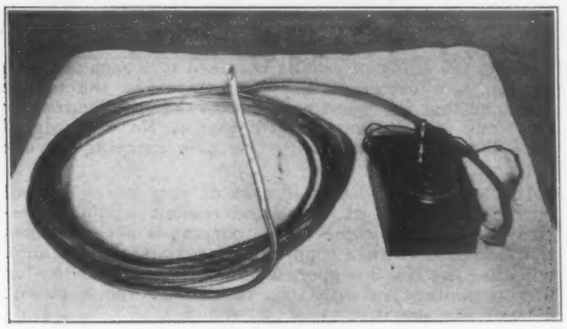

Fig. 2

of a No. 14 duplex cable (see Fig. 2), the lead covering serving as the battery lead or third wire for the bridge balance. This makes a very small unit which may be conveniently placed at any point in the conduit section and by the installation of several units in the cross section of the conduit (see Fig. 1), very good comparisons can be made for determining the heat flow.

The insertion of the unit in ducts of old conduits by using a flexible 3-conductor cord in place of the cable, will also prove valuable, though owing to the uncertainty of the contact so established, the temperatures read will not be so reliable.

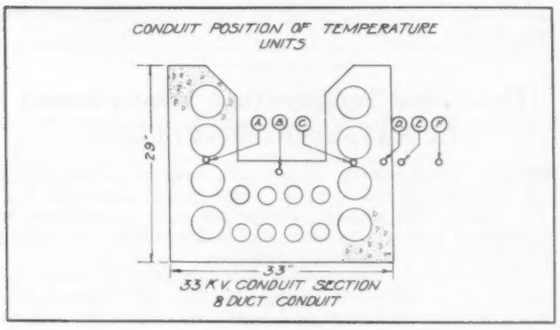

Fig. 3

When installing important heavy duty cables a temperature unit is wiped onto the lead sheath of the cable and installed with it, being pulled into the duct under lead seal as part of the power cable.

A measurement taken on all of the temperature units gives the temperature gradient in degrees centigrade from the cable sheath to a point one foot in the earth outside of the conduit section.

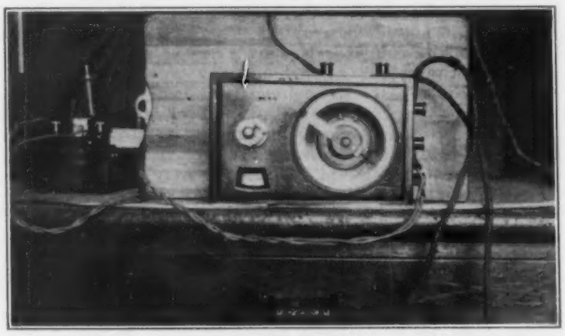

Fig. 4

Fig. 3 shows a diagram of the temperature bridge and the resistance values used. With slide wire S_2 at double the radius of S_1 it is possible to balance the bridge by turning but one dial which holds both sliders, and the pointer shows the temperature directly in degrees centigrade for each position (see Fig. 4).

Temperature measurements will be made at intervals of heavy load and during hot weather. Conduit temperatures and radiation characteristics can be determined and cable temperatures can be accurately known. Safe working temperatures for heavy duty cables can be determined and made use of in load dispatching. Conduit design can be adjusted to correct for poor heat flow within the conduit and to ground surface.

There are several elements entering into the solution of the duct line temperature problem, such as the type and spacing of the ducts, the dimensions of the envelope and its makeup and the moisture content of the soil and its heat carrying capacity. Tests of moisture content seem to vary from about 2 per cent to 18 per cent with an average of about 5 per cent for most soils in Coast cities.

Several of the Pacific Coast companies are making installations of experimental conduit lines with controlled loading and temperature indicators with various duct sections to obtain data on this problem.

Factors Governing Underground Construction

Report of Underground Systems Bureau, Technical Section*

SEVERAL of the Pacific Coast companies have standards which are prepared and used in ordering cable. These specifications cover the thickness of lead and insulation, loading, testing, inspection of the cable as manufactured, the furnishing of a certain percentage of the cable for testing, packing, and directions for shipping.

It is common practice for Coast companies to be rather liberal in the specifications and use of cable which is desirable for durability and operation.

There seems to be no common specification in use, yet for all practical purposes they are sufficiently close to render manufacturing features satisfactory. The larger companies purchase cable in such large quantities that

* C. H. Jenkins, Los Angeles Bureau of Power and Light, chairman; H. H. Buell, Pacific Gas and Electric Company; Vinton Smith, Standard Underground Cable Company; M. O. Bolser, Los Angeles Bureau of Power and Light; P. E. Chapman, Pacific Gas and Electric Company; G. H. Hagar, Great Western Power Company; H. S. Minor, San Joaquin Light & Power Corporation; R. R. Cowles, Pacific Gas and Electric Company; N. B. Hinson, Southern California Edison Company; H. W. Keesling, Pacific Gas and Electric Company; K. B. Ayres, San Diego Consolidated Gas & Electric Company; R. S. Daniels, The California Oregon Power Company; D. J. Kelly, San Diego Consolidated Gas & Electric Company; Raymond Lewelling, Los Angeles Bureau of Power and Light; O. C. Miller, Los Angeles Gas & Electric Corporation; Z. T. Pettit, Los Angeles Gas & Electric Corporation; R. C. Powell, Pacific Gas and Electric Company; A. C. Putnam, The Southern Sierras Power Company; J. C. Pyle, Standard Underground Cable Company; G. A. Riley, Los Angeles Gas & Electric Corporation; R. G. Sheppard, Southern California Edison Company; E. J. Willits, Los Angeles Bureau of Power and Light.

a common standard specification is hardly necessary from a price standpoint.

It is the general opinion that cable should be purchased in sections such that the total reel weight should not exceed seven and one-half tons, and this weight only when extremely heavy section cable is to be handled. This is to reduce the possibility of the cable being bruised or the lead crystalized. Reels should be properly lagged, with a packing between the cable and the lagging as a cushion to protect the cable, and steel bands placed over the lagging, especially when packed for long distance shipment.

Manhole and Conduit Construction

These seems to be no common standard of manhole and vault construction, each company having its own standards. The increased density of loads which necessitate more and larger cables, transformers and equipment tends to require larger manholes and vaults.

The general design is quite uniform so far as wall thickness and strength are concerned. Both brick and concrete are used and with the exception of the roof are as a rule not reinforced. Used steel rails are in common use for roof reinforcing, due to their great strength and facility for installing and the placing of manhole castings. It is felt that in this matter we should not be too conservative for the reason that a single failure of manholes would be disastrous and far reaching in effect and probably would cause the enactment of more stringent laws governing the construction of them in public highways. More attention is being given to the design of manholes and vaults to facilitate the ease and security of cable racking. Conduit line entrances are properly recessed to permit of installing cable without sharp bending. More space is provided for installation of junction boxes and greater attention is given to obtain safe and adequate space for men working therein. Consideration is given to the matter of waterproofing of manholes and vaults. Some systems are arranged for connections to sewer while others are waterproofed and carefully sealed to exclude water, in which case forced ventilating systems are usually installed especially in transformer vaults to provide air circulation and low temperature conditions.

To date fibre has been in general use for conduit construction on the Pacific Coast. There is a tendency to increase the diameter of the duct to permit of installing larger cable—3½-in. and 4-in. ducts being in nearly exclusive present day use. The number of ducts, form of the conduit section, and the duct separation are given considerable thought. Several Coast companies are experimenting with concrete duct. Some difficulty is experienced due to the roughness of the inner surface, yet this handicap is expected to be overcome. The heat conducting quality of concrete duct is quite pronounced over that of fibre or pump log, which in itself is an important factor.

High-Voltage Cables—35 kv. and Higher

This subject is given considerable study. The use of high-voltage cable is rapidly coming into extensive use because of the constantly increasing density of loads and necessity for serving them through territory where overhead lines are not practicable or permissible.

Foreign and American cable manufacturers are rapidly improving the art of cable making, and have recently made single conductor paper insulated lead cable which is satisfactorily undergoing tests at 135-kv. potential between phases. This cable seems to differ from the earlier cable principally in that it is composed of graded paper insulation and impregnated with light oil compound. Paper of relative high dielectric strength is placed near the conductor and with gradually decreasing strength toward the outside. The high dielectric strength paper offers considerable difficulty for proper impregnation. A hollow core cable is used to facilitate impregnation. The compound is applied through the core, thereby obtaining the greatest dielectric strength near the conductor. Freedom from voids in the insulation and formation of occluded spaces is eliminated. Conservators or chambers for holding quantities of compound are attached to the joints and potheads to insure the cable remaining constantly full even though the lead sheath undergoes deformation.

Quite a considerable amount of 35-kv. triplex cable is in satisfactory operation on the Pacific Coast. It is paper insulated and impregnated with blended compound.

A recent 45-kv. cable installation by the Great Western Power Company is of distinct importance, it being an advance in the use of triplex high voltage. Each conductor is composed of one layer of 22-strand copper .0592-in. diameter each, with a total area of approximately 77,000 cir. mils surrounding a 13/32 in. hemp center.

The installation is saturate paper 13/32 x 6/32 in. all of 5 mill thickness.

The sheath is 1/8 in. lead covered with two layers of reinforced rubber, each layer being .033 in. thick. A jute bed is placed on the rubber and over all a No. 3 B.W.G. steel wire armor is applied.

The cable is tested at 90,000 volts between conductors for five minutes and at 55,000 volts between conductors and sheath for five minutes.

This cable is being installed across Napa Creek, north of San Francisco Bay, with 30-ft. pole risers at each end and without splices.

It is equipped with terminals of the three-conductor flat outdoor-type potheads with adjacent bushings on 36-in. centers. The body of the pothead is made of sheet steel. Both cable and potheads are American manufacture.

This cable is connected as a link in an overhead line operated at 45,000 volts. At this date the cable has not been placed in service. Its operating performance will be of considerable interest.

Revision of the National Electrical Safety Code—Sec. 29

Consideration was given to the draft of the proposed revision of the National Electrical Safety Code as submitted by the N.E.L.A. The larger part of the section was found to be good practice and satisfactory except where specific dimensions are provided, which are generally more conservative than the California state law requirements.

Rcommendations

The committee recommends the following points of interest to be followed for the next year's investigation and discussion:

1. Improved design in outdoor and indoor cable terminals.
2. Study of the Kenetron testing set.
3. Metal conduits as used for underground laterals, particularly as to the treatment of these conduits in order to lengthen their life in the ground.
4. High-voltage underground cables.
5. Cement duct.
6. Junction boxes.

Cable-Splicing Instruction

By PAUL E. CHAPMAN*

ONE member company has recently been confronted with the problem of securing good cable splicers for the joining and splicing of underground lead covered cables. The art of cable splicing has not been practiced by many men, and it has been impossible to secure good artisans in this line.

In order to meet the situation a cable splicing school was started, wherein men could be educated in the art of cable splicing and in the installation of underground structures which go with cable work. The first class of men, approximately twenty, has most of its members working at the present time as cable splicers and cable splicer apprentices. It has been found possible to educate these men during a period of several weeks time so that they were able to do cold work satisfactorily.

The original school was carried on during the day time. This practice has now been changed and instruction is given two nights a week over a three months period two hours each night to a class of thirty-six men. Most of the men who have entered these classes are young and readily apply themselves to the carrying out of the instructions given them by their teachers. The results have been very satisfactory. There will be enough men instructed in the art of cable splicing so that hereafter the company will not have to meet the problem of incompetent men in order to cope with a cable splicing emergency.

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* Report of Underground Systems Bureau, Technical Section.

Evening instruction is divided into a one-hour lecture and one-hour actual work. Some of the evening periods are given entirely to a two-hour working period by the student, as it requires practically that time to prepare his metal and wipe a large joint. The men

Fig. 1

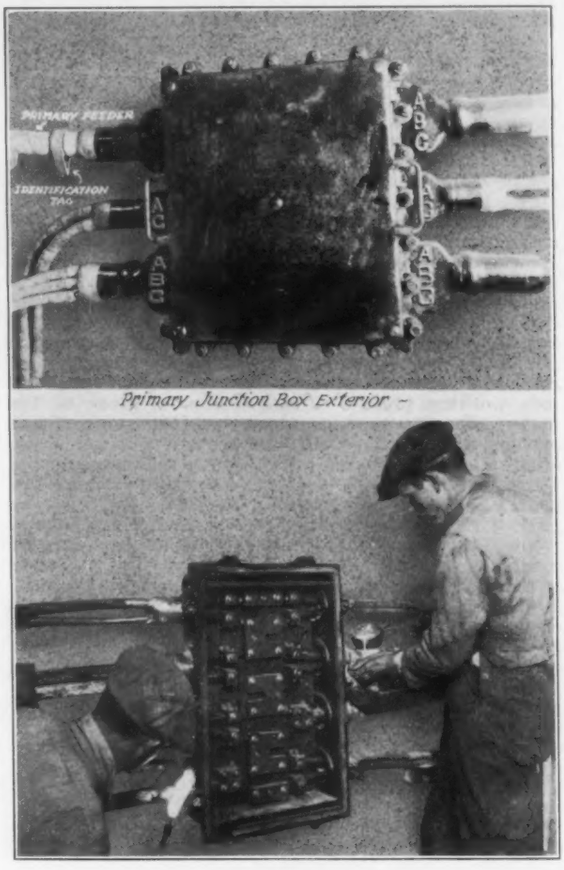
are all dressed alike. They observe absolute discipline in the class room, are prompt in their attendance and neat and efficient in the work they do. It is absolutely necessary that strict discipline, alertness and neatness be observed by the students in order that they may be on confusion and no unnecessary delay in putting on the evening's work.

The men furnish their own uniforms and small hand tools. The company furnishes all the necessary instruction, material and larger tools. Elementary electricity and the fundamentals governing the art of cable splicing, box work, installation of transformers and cable fault finding are given the men in the lecture period. The actual work consists of low voltage and high voltage lead cable splicing, junction box work, installation and connecting of underground transformers, the installation of inside and outside potheads and terminals.

Cable Splicers' Manual

In conjunction with the cable splicing school it was found necessary to have a text book for instruction purposes, this book of such nature that the student could readily understand the subjects presented. On looking over the various texts published, nothing was found which covered cable splicing in a comprehensive and practical way. It was decided therefore to draw up a manual covering the art of cable splicing as practiced by the company holding the school. The material as presented consists first of a preface covering school organization and the conduct of the student in the class room, followed by an outline of cable splicing, the subjects covered and the tools and materials used.

A chapter is devoted to the location where cable splices are made and why they are made, also a chapter is given on electrical generation and distribution, together with a number of diagrams showing the distribution system for the various classes of current and voltage. The construction of cables, the material which enters the construction from the copper conductor to the ultimate lead covering, is briefly described, also a small amount of text given to the explanation of submarine cables. The balance and main part of the text is devoted to the installation of lead covered cables in duct lines, and the splicing or joining of these cables. The various styles of boxes, cut-outs, oil switches and subway transformers are well explained, both in the text and by diagram. The final chapter in the text is given to safety rules as applied to underground work. It is felt that this manual will be a great aid in the education of cable splicers.



Primary Junction Box Exterior

Fig. 2

The first manuals issued can be improved. As soon as they are used and their various discrepancies noted the book will be revised and re-issued. The object was to obtain as near as possible a manual of cable splicing that would cover the field in a practical way, the text so worded and the diagrams so drawn that the average man who follows this class of work could readily understand it. The text and diagrams, together with such photographs that are used, are neatly bound together and enclosed within a serviceable cardboard cover.

Figs. 1 and 2 show typical photographs contained in the manual.

New Developments in Design, Application and Operation of Electrical Operation

Report of Apparatus Bureau, Technical Section*

THE apparatus bureau of the Pacific Coast Electrical Association has endeavored this year to keep in touch with the new developments and applications of such electrical apparatus as are of special interest and benefit not only to the members of the Bureau but to the various member companies whose employees are associated in this work. Electrical apparatus covers such a wide and varied field that it can not be fully covered each year. However, there are many studies which can be made and reported upon to the benefit of all. In addition there is the work of keeping in touch with new developments.

So closely is the study of electrical equipment associated with the story of its functioning that it is necessary carefully to consider the operating problems involved and to exchange operating practices and experiences. The apparatus bureau in its program and its meetings has endeavored to be a clearing-house for such information as is of value to its members.

Organization

The organization of the apparatus bureau this year is on the company correspondent plan. The bureau chairman selected one representative from each member company, who in turn selected his assistants from his company and assigned to them certain parts of the program of study for which to be responsible. This plan very materially saved in the matter of correspondence for the bureau chairman and resulted in the selection of more interested and better qualified men than if selected at a distance by the bureau chairman.

The company correspondents and the company members have been urged that where possible they endeavor to hold meetings of their company representatives to discuss the work in hand so that all will become familiar with the various phases of the different problems.

There has been a ready response from the men selected as company correspondents and from the members selected by them. The personnel of this committee as shown by the accompanying list is rather large, but it is mostly due to the members selected by the company correspondents as assistants. The work of the apparatus bureau covers such a wide field that it is necessary to have a great variety of talent to accomlish the desired results. There has been an effort to interest new members in the work to replace the older members who for one cause or another now find their time taken up with other duties and can not give the time they otherwise would like to give to the work of the bureau.

This work is also a study of the every-day problems of each member and by a wide exchange of ideas all are helped in the performance of their daily tasks. A large and interested membership together with live and interesting topics gives the greatest good to all and to the companies represented.

Program and Meetings

Three meetings of the apparatus bureau have been held, all in conjunction with the meetings of the Technical Section.

The first of these meetings was held in Los Angeles on Sept. 18, 1924. There was an attendance of sixty and at this time was discussed the program of the year. There were many interesting discussions and suggestions. This program is outlined as follows:

- Oil Circuit Breakers
  - Progress in higher voltage circuit breakers
  - Progress in increasing rupturing capacity
    - By additions to existing breakers
    - By increase in speed of break
    - By increase in number of breaks per phase
  - Rating of breakers—particularly those manufactured on the Pacific Coast
  - In this connection it is desired that power line tests be arranged if possible through approval of system executives
  - Operating experiences
    - Such experiences would be of particular interest as regards rating of breakers if these can be checked up with system calculating boards.
  - Use of transformer oil as a substitute oil
  - Progress in the methods of interlock between oil circuit breakers and disconnect switches
  - Miscellaneous
- Transformers
  - Polarity
    - Additive vs. subtractive polarity standard for distribution transformers
    - Questions should be settled more definitely and Pacific Coast companies present unified opinion
  - Voltages
    - Grouping of standard taps of transformers
    - Relative satisfaction for both station and distribution sizes.
  - New design
    - Application of new ideas to existing equipment
  - Cooling
    - Automobile type radiators
    - Results after long period of service should yield information
- Power interchange
  - Preeminence of Pacific Coast in this field
  - Problems of various frequencies and voltages
  - Discussion of wide interest
- Frequency changers
  - Applications to various systems should be studied
  - Experiences of users of interest and value
- Voltage control
  - By means of tap changers operated under load conditions
    - Automatic
    - Manually operated
  - Booster or crusher transformers for proper voltage conditions
- Relays and relay applications
  - New types of relays for transmission network protection
  - New types of relays for protection of equipment from internal trouble
  - New or unusual applications of older types of relays
  - System calculating boards
    - Value in obtaining proper relay settings
    - Value in selection of adequate breaker equipment
  - Miscellaneous

* Chairman: C. E. Schnell, San Joaquin Light & Power Corporation. Members-at-large: R. H. Halpenny, Southern Sierras Power Company; S. J. Lisberger, Pacific Gas and Electric Company; L. J. Moore, San Joaquin Light & Power Corporation; E. R. Stauffacher, Southern California Edison Company. Company correspondents and members: Los Angeles Bureau of Power and Light—J. C. Alberts, H. H. Cox, C. P. Garman, Roy Martindale, O. W. Wingard; The California Oregon Power Company—R. S. Daniels, H. G. Getchel, Harvey Gilman, O. G. Steele; City of San Francisco—Paul J. Ost; Coast Counties Gas & Electric Company—A. E. Strong, W. R. Van Bokkelen; Coast Valleys Gas & Electric Company—G. A. Peers, T. W. Snell; Garland-Affolter Company—G. E. Armstrong, P. H. Affolter; General Electric Company—J. H. Cunningham, H. E. Fuqua, W. E. Melarkey, W. C. North, H. C. Stanley, W. C. Smith; Great Western Power Company—C. F. Benham, G. H. Hagar, D. G. Kramer, G. K. Morrison, J. H. Paget; C. E. Ingalls, Manufacturers' Agent—C. E. Ingalls; Los Angeles Gas & Electric Corporation—F. E. Dellinger, F. R. Knight, G. A. Riley; Ontario Power Company—A. J. Hall; Pacific Gas and Electric Company—E. A. Crellin, B. D. Dexter, R. B. Kellogg, H. S. Lane, H. A. Laidlaw, H. T. Suteliffe, R. W. Wilkins; San Diego Consolidated Gas & Electric Company—K. B. Ayres, A. S. Glasgow, E. D. Sherwin, C. W. Wiggins; San Joaquin Light & Power Corporation—R. C. Denny, R. D. Likely, H. H. Minor, H. S. Minor; Southern California Edison Company—L. L. Dyer, J. C. Gaylord, D. J. Kennelly, C. C. Long, F. H. Mayer, H. L. Sampson; The Southern Sierras Power Company—M. L. Baden, M. E. Jones, P. H. Yelton; H. B. Squires Company—S. P. Russell, R. P. Snoke; Westinghouse Electric & Manufacturing Company—J. E. Bridges, A. W. Copley, P. B. Garrett, W. P. L'Hommedieu, R. C. Stackhouse.

Automatic generating plants and substations
- Subject of continued interest due to new applications and installations
- Experiences should be discussed as often as possible
- Operating costs data most important

Compilation of joint reports
- With hydraulic power bureau on existing hydroelectric stations
  - Apparatus bueau to supply available information on electrical equipment
- With prime movers bureau on existing steam plants
  - Apparatus bureau to supply available information on electrical equipment

Station electrical grounds and control of grounds
- Further discussion desired
- Standard methods of preparing electrical grounds is objective
- Methods of determining value of ground resistance

Fire-fighting equipment.
- Study of means used to extinguish fires of different natures
  - Generators
  - Transformers
  - Cell compartments

Other topics were discussed the study of which it was believed would be of value to the bureau, but owing to the length of the program it was decided to omit them as definite parts of the program. Topics omitted were:

Power factor correction
Lightning arresters.
High tension fuses

Study of these subjects might well be made in the future as there are continual developments along each of these lines. Radio interference from power lines was discussed and while considered important, was believed to be logically a topic for the inductive coordination bureau to study.

The second meeting of the year was held in San Francisco, Jan. 8, and 9, 1925, in conjunction with the other bureaus of the Technical Section. Attendance at this meeting was forty-five and the discussion was devoted to the program as outlined at the Los Angeles meeting.

The third meeting was held in Fresno, March 26 and 27, 1925, also in conjunction with the various bureaus of the Technical Section. Attendance again was forty-five and discussion was devoted to further consideration of the program and to the report submitted for the year. Inasmuch as this was the final meeting of the year for the bureau on account of there being no Pacific Coast Convention, efforts were made to close up the work insofar as possible and to suggest such topics as might be desirable for future study.

The really important points of these meetings will be reviewed later on in this report under their respective headings.

Cooperation with Electrical Apparatus Committee, Technical Section, N. E. L. A.

There is a very earnest desire on the part of the apparatus bureau, P. C. E. A., to work in close conjunction and harmony with the national electrical apparatus committee. It is the belief of the chairman that there has been much good accomplished.

The program of this bureau, although formulated before the program of the national committee was made public, comes into very close contact with the latter in a number of important subjects. Particularly in the subjects of oil circuit breakers and protective equipment, a.c. substations, transformers and regulators, hazards and safety and system connection schemes. Certain of the sub-topics of this bureau's program have been suggested for study by certain subcommittees of the national electrical apparatus committee through A. A. Meyer, the chairman, and this bureau well may feel proud that its efforts are recognized outside of the local field.

In the matter of close cooperation with the national committee there have been many questionnaires sent out which have been freely answered. Answers have been forwarded to the various national subcommittee chairmen.

These questionnaires have been as follows:

(A) Subcommittee on Transformers and Regulators
- (1) Fire protection
- (2) Temperature indicators for distribution transformers
- (3) Prevention of congealing of oil in conservative piping
- (4) Practices regarding oil storage tanks
- (5) Manufacturers' methods used in checking quality of oil
- (6) Effects on transformers of short circuits with sustained primary voltage.
- (7) Transformer and regulator tap changers.

(B) Subcommittee on Oil Circuit Breakers and Protective Equipment
- (1) Operating duty for automatic reclosing oil circuit breakers

(C) Subcommittee on a.c. Substations
- (1) Grounding practices
- (2) Standard symbols for substation wiring diagrams
- (3) Interlocks between oil circuit breakers and disconnect switches

(D) Subcommittee on Operating Methods, Routine and Facilities
[This is a new committee with a very interesting program which is taking up only two subjects this year and on which questionnaires have been sent out as follows:]
- (1) Switching and grounding
- (2) Inspection and maintenance of apparatus and equipment.

(E) Subcommittee on Hazards and Safety
- (1) Fire-fighting equipment for oil-filled apparatus
- (2) Troubles with certain types of foam extinguishers

(F) System Connection Schemes Subcommittee
- (1) Transmission lines
- (2) Distribution lines (including a.c. low-voltage net works)
- (3) Station buses and bus connections of lines and equipment
- (4) Operating practice.

One of the fine efforts toward closer cooperation between the national committee and the divisional committees has been the exchange between th divisional committees of minutes of past meetings. Many points of interest in local study are discussed and reported upon in these divisional committee minutes and these have been called to the attention of this bureau to advantage. After each of the local meetings the minutes have been sent to the national electrical apparatus committee chairman, and to each chairman of the divisional committee, this being in addition to the copies of minutes distributed with the local bureau organization.

The apparatus bureau has been particularly fortunate in being represented at two meetings of the national electrical apparatus committee this year. J. C. Gaylord of the Southern California Edison Company, Los Angeles, attended the St. Louis meeting Oct. 20 and 21, 1924, and carried to the national committee a message of our efforts on the Pacific Coast. A fine report of the meeting was brought back. The bureau chairman attended the national committee meetings in Cleveland Feb. 4 and 5, 1925, and endeavored to uphold the Pacific Coast before the national committee by telling of Pacific Coast work and effort and by taking part in the discussion. Such contacts not only greatly help the members fortunate enough to attend these meetings but also help the membership of this bureau through the closer contacts which afterwards are maintained.

Oil-Circuit Breakers

Requirements as regards rupturing capacity of oil-circuit breakers on a system has increased with each addition to plant or transmission line capacity and with each interconnection with other systems. Voltage of transmission lines has increased steadily so that oil-circuit breakers now are one of the most expensive parts of a station equipment. With the great desire on the part of power companies to guarantee continuity of service, there are built duplicate transmission lines each of which adds to the problem of circuit breaker operation and cost.

This committee is interested in the story of what the various manufacturers are doing to meet this ever-increasing demand and also is interested in knowing how the problems are being met by the operating companies themselves whenever the point is reached that their existing circuit breakers are too small, hence the outline in our program:

- (1) Progress in higher voltage breakers
- (2) Progress in increasing rupturing capacity
  - (a) By additions to existing breakers
  - (b) By increase in speed of break
  - (c) By increase in number of breakers per phase

Among the manufacturers there seem to be two divisions of opinion and switch design governing the direction of their efforts. One of these is the double-break switch with explosion chambers, relief vents and a comparatively small volume of oil. The other is the

multi-break switch with a much larger volume of oil. The multi-break switch is now being made with up to ten breaks per phase. Both types of breakers have been used by member companies with excellent results.

The following papers have been submitted, and appear in full later in this report:

"Increasing Oil-Circuit Breaker Interrupting Capacity," by H. H. Cox; "Oil-Circuit Breaker Experiences and Problems," by H. S. Minor; "Results of Tests on Oil-Circuit Breakers of Pacific Coast Manufacture;" "Interrupting Capacity of Oil-Circuit Breakers Manufactured on the Pacific Coast," by C. C. Long and L. L. Dyer; "Short Circuit Tests on Kelman Type Y15 Oil-Circuit Breakers," by C. C. Long and L. L. Dyer; "High-Tension Oil-Circuit Breakers," by R. W. Wilkins, B. D. Dexter and H. T. Sutcliffe; and "Short Circuit Duty on Kelman Switches at Laguna Bell Station," by E. R. Stauffacher.

There should be impressed upon them and also upon the operating men the fact that the power companies are groping in the dark and that the gamble is on the shoulders of the power companies if they continue to purchase oil-circuit breakers as they would not purchase any other equipment.

Through the interest and efforts of L. J. Moore of the San Joaquin Light & Power Corporation and J. P. Jollyman of the Pacific Gas and Electric Company it is possible that certain tests may be made on high-voltage breakers this fall. The information from such tests should be valuable to both operating men and manufacturers. It is the hope of this committee that there will be continued efforts along the line of oil-circuit breaker tests and that the information gained will be given to this committee. Certain oil-circuit breaker manufacturers have offered complete cooperation in these tests.

In order that much information might be gained from operating experiences with oil-circuit breakers, a subcommittee was appointed to study the subject and devise a standard form for use in order that infromation gathered from oil-circuit breaker inspection might be uniform. In this way the operation of similar oil-circuit breakers on different systems may be compared. The membership of this committee is as follows:

J. C. Gaylord, chairman; Southern California Edison Company.
C. F. Benham, Great Western Power Company.
H. A. Laidlaw, Pacific Gas and Electric Company.
R. C. Denny, San Joaquin Light & Power Corporation.
H. H. Cox, Los Angeles Bureau of Power and Light.

The form agreed upon is shown in Fig. 1 and it is the recommendation of the subcommittee that it be used by the operating departments of the various companies for oil-circuit breaker inspection reports.

OIL SWITCH OPERATING RECORD

Operating Company _____ Date _____
Time A.M. _____
Time P.M. _____

Switch Location _____ Number or Company Designation _____

Manufacturer's Name _____ No. _____ Automatic _____
Type Switch Non-auto _____
No. Breaks _____
Type of oil used _____

Voltage _____ Rated Cur. Capacity Carrying _____ Rupturing _____

No. of automatic openings since last overhaul _____

Nature of overload Ground _____ Single Phase _____ Three Phase _____ Approx.Cur. Interrupted _____

Findings:

		Phase A	Phase B	Phase C
General External Conditions.	(Bushings broken or cracked,			
	(Switch top broken or cracked,			
	(Tanks bulged or split,			
	(Oil spillage or leakage,			
Internal Conditions	(Bushings			
	(Blades			
	(Contacts			
	(Oil (Dirty wet or carbonized)			

Was opening satisfactory _____

Fig. 1—Suggested form for oil-switch operating record. The use of this record form by all member companies will supply useful information for the further consideration of the apparatus bureau.

It is safe to say that practically all substations built more than five years ago are loaded up to or above their capacity and are obsolete in design at the present time. The circuits which they were resigned to feed also are, in general, overloaded and obsolete in design so that in many cases they require more attention as to voltage regulation than good modern practice would justify. Aside from the actual loading of transformers, regulators and other substation equipment, the oil-circut breaker situation is the most acute. As system capacities have increased possible short circuits have increased rapidly. Comparatively few of the circuit breakers originally installed in different substations are capable of interrupting the maximum short circuits to which they might be subjected today.

Much attention has been given to the best method of meeting this situation. Realignment of system connections, including sectionalizing of transmission lines and substation buses, has given relief in some cases. In other cases it has been necessary to accompany the sectionalizing by making the circuit breakers non-automatic. Again, in some instances reactors have been installed to give the necessary relief to the circuit breakers.

However, the requirements of oil-circuit breakers are becoming more definitely known each day. This is not only from past experience, but also by reason of the fact that many companies now are equipped with system test or calculating boards whereby each problem can be set up and the answer made known. Knowing that and also with a foresight into the probable system growth, it becomes increasingly more difficult to reconcile our definite requirements to the purchase of equipment of which only part of the characteristics are known. Only the fact that there is some margin in price at all reconciles this lack of knowledge. Price becomes increasingly less important as the loss in case of shut-down due to faulty switch operation mounts up. Manufacturers should endeavor to establish definite ratings for their switches.

Suggested Standard Interrupting Ratings for Oil-Circuit Breakers

The electrical apparatus committee, Technical National Section, N.E.L.A., through its subcommittee on oil-circuit breakers is planning to ask the manufacturers of oil-circuit breakers to standardize upon oil-circuit breakers of the following interrupting rating:

25,000 kva.	250,000 kva.
50,000 kva.	500,000 kva.
75,000 kva.	1,000,000 kva.
125,000 kva.	1,500,000 kva.

Use of Transformer Oil as a Substitute for Switch Oil

There has been considerable discussion as to the advantage of one oil for all oil immersed apparatus. Certain of the manufacturers of oil-circuit breakers have recommended the use of their transformer oil in oil-circuit breakers where the temperature does not go below 0 deg. C. Another company takes the stand that only switch oil as such should be used in circuit breakers.

As is the case in getting at the answer of an important problem, the men of the operating companies attack the problem in their own way and obtain the answer from their own experience. Many of the member companies of the P.C.E.A. are using transformer oil in oil-circuit breakers and are getting very excellent results. This statement applies to switches operating at 70 kv. and 120 kv. and whose duty is most severe.

Aside from the saving in cost of storing and handling only one oil over that of two oils, there is a very considerable saving in the cost per gallon of transformer oil over that of switch oil. In large switches this is a considerable amount.

It is the recommendation of the chairman that this topic be discussed often and that any failures of oil-circuit breakers due to the use of transformer oil be reported.

Progress in Methods of Interlock Between Oil-Circuit Breakers and Disconnect Switches

One of the most important factors of present-day central-station construction is the proper design and operation of adequate interlocking between oil-circuit breakers and disconnecting switches. Especially is this true in view of the larger concentration of power within single generating stations and large substations. There

has been designed and installed interlocking equipment to prevent the disconnecting switches being operated in proper sequence. These designs have been thoroughly tested out in actual practice. Of course it is understood that the views of operating companies in regard to interlocking do not always coincide, one company requiring more interlocking than another due primarily to the character of the operating force employed. The usual interlocking consists of a mechanical device to prevent opening the disconnecting switch unless the oil-breaker first has been opened and also to prevent the removal of the oil-circuit breaker or disconnecting switch-cell door (both doors usually combined in one) unless the oil breaker and disconnecting switch both are open. However, it oftentimes becomes necessary to operate the oil breaker with the disconnecting switches in the open position so that contact pressure and alignment can be checked. To accomplish this an additional interlock has been devised that will enable a single operator to disengage the regular interlocking arrangement and thus be able to operate the oil breaker with the disconnecting switches open. The design of this disengaging feature is such that one key is employed and this key is in possession of the particular operator whose duty it is to check the contact alignment, the purpose of this arrangement being that it will not be possible for the regular station attendants to either open or close the breaker while the contacts are being checked. This interlocking feature often is demanded as an additional safeguard along with the tagging of proper control switches as usually employed. All of the foregoing of course assumes that gang-operated disconnecting switches are used. That is three or six disconnecting-switch poles operated simultaneously from one handle lever. The normal scheme of interlocking, together with gang-operated disconnecting switches, can also be employed in a large number of station layouts.

Target indicating devices also have been used. However the success of the whole scheme of interlocking depends upon a very high grade of intelligence on the part of the operator and very careful checking of circuits before attempting to work upon them. No scheme of interlocking can be successful unless this is true.

Transformers

Polarity—The question of desirable polarity for distribution transformers, whether additive or subtractive should be standard throughout the range of distribution transformers, has been settled by the report of B. L. Jamison, chairman of the subcommittee on transformers and regulators, electrical apparatus committee, N.E.L.A. The report is as follows:

"In accordance with the subcommittee action at St. Louis on Oct. 20, 1924, I am sending you herewith copy of the summary of questionnaires circulated by the overhead systems and the electrical apparatus committees regarding the above topic. This is shown in Table I. This tabulation is sent you for your information as our subcommittee is not contemplating any action this year in this matter."

Voltages—The question of whether or not the grouping of standard taps of transformers is satisfactory for both station and distribution sizes is one which has been discussed but upon which no definite action was taken. One of the problems which presents itself to the member companies of the P.C.E.A. is outlined in a paper on "Distribution Transformer Ratios" submitted by H. H. Minor. This paper is printed in full later in this report.

The points raised in this paper are important enough for careful consideration especially in view of the fact that the electrical apparatus committee, N.E.L.A., has asked for a careful review of voltage ratings and ratios for transformers. Hence this bureau has decided to work in conjunction with the overhead systems bureau on this matter in order to present a joint recommendation as to pertinent needs.

A report from the Pacific Gas and Electric Company covering the "Relation of Various Distribution Transformer Primary Voltages" also appears in full later in this report.

New Departures in Transformer Design and Applications of New Ideas to Present Equipment

Under this topic there has been a consistent effort on the part of the manufacturers to provide thermometers and temperature-indicating devices of greater accuracy and reliability that the maximum capacity of transformers may be utilized. With such devices less attention may be paid to the rated ampere capacity of the transformer and more attention given to its thermal capacity which is really the limiting feature.

TABLE I

		No. of transformers	Kva. capacity	Per cent of total
(1)	In favor of **additive polarity** and will order additive irrespective of standard adopted	229,634	3,024,158	50.0
(2)	In favor of **additive polarity** and will order subtractive if adopted as standard	89,975	1,201,962	20.0
(3)	Total in favor of additive polarity	319,609	4,235,120	70.0
(4)	In favor of **subtractive polarity**	64,299	1,305,344	21.6
(5)	Indifferent	26,527	505,371	8.4
	Total answering questionnaire	410,435	6,045,835	100.0

One of the newer types of transformer-load indicators is a device which may be applied to distribution transformers by lifting the cover and inserting the bulk of the device in the oil. Upon replacing the cover the indicating device is plainly visible and being of the dial type show an easily distinguished signal when safe load conditions have been exceeded. As well as showing overloaded transformers it also shows underloaded transformers. The really interesting part of this instrument is that it automatically corrects the reading of the indicating hand for variations in the ambient temperature. When transformers are loaded on the basis of oil temperature alone there is great danger of overheating and burning out the coils. With the instrument described the thermometer immersed in oil gives a reading based upon the actual oil temperature and this reading then is modified by the ambient thermometer in the instrument case in a way such that the reading of the hand on the dial is a positive indication of the percentage of safe load on the transformer. The ambient correction feature not only permits higher loading of the transformers in winter and in the evening when the surrounding air is cool, but also gives a warning when the load on the transformer reaches a dangerous point during the heat of summer or during the daytime under the direct rays of the sun.

Cooling of Transformers

An increasing demand from the power companies for larger sizes of self-cooled transformers has been made until now this type of transformer is manufactured in sizes up to 20,000-kva. units. In order to ship these large transformers with oil it is sometimes necessary or desirable to remove the radiators. To eliminate the necessity of withdrawing the oil when removing or replacing the radiators there has been developed by one manufacturing company a very compact type of poppet valve which is closed at such times enabling the radiator to be removed or replaced as desired. When open, this valve does not interfere with the circulation of the oil in the radiator and in no way lessens the cooling effect.

Another insight into this self-cooled transformer situation is had with the development of a new form of radiator by the Pittsburgh Transformer Company which reports as follows:

With the more extensive use of self-cooled, radiator-type transformers the problems involving weights, space for shipment and installation of radiators upon arrival at destination become more difficult.

Shipment of self-cooled, radiator-type transformers has in the past oft times necessitated the removal of the radiators before shipment from the factory in order to avoid damage to the radiator while in transit and to meet shipping space limitations. Such conditions necessitate assembling the radiators on the transformer after the shipment arrives at its destination. This entails additional expense, delay and annoyance in placing the transformers in operation. This condition is particularly true when large transformers requiring from fifteen to twenty radiators per transformer are involved.

When assembling radiators in the field it is more or less difficult to secure an oil-tight fit due to the difficulty in securing proper alignment of flange-bolt holes, gaskets, etc. Also there is danger that the openings on the radiators may not be properly protected thereby allowing moisture to enter the radiator. If this point is not carefully watched the moisture may not be en-

TABLE II.—Monthly summary of automatic switch operations, Southern California Edison Company.
JANUARY 1925
An analysis based upon the ideal operation of protective equipment
Trouble on 2,300-volt and 4,000-volt circuits
and equipment is neglected.

	Potentials in kv.						
	11	16	33	66	150 & 220	Total cases	Percent of total
Clearance of trouble							
1. Total number of cases possible to be cleared. (Includes trouble which could be cleared by the operation of one or more automatic circuit breakers. Each case of trouble counts as one, regardless of the number of operations required to clear the trouble. If a switch is closed in for test and trips out this does not count as another case of trouble)	40	8	2	8	6	64	100
2. Total cases cleared. (Includes the number of cases of trouble cleared, thereby preventing a system interruption. May include the interruption of other circuits or equipment.)	40	8	2	8	5	63	98
3. Total cases cleared correctly on the voltage concerned. (Includes the cases of trouble in which a minimum number of automatic switches operated on the voltage concerned and no necessary switches on this voltage failed to operate. However, some switches may trip out incorrectly on other voltages.)	39	8	1	6	5	59	92
4. Total cases cleared correctly considering switch operations on all voltages. (Tripping out of switches by over-voltage or under-voltage relays are considered as correct operations.)	39	7	0	5	5	56	88
Automatic switch operations							
1. Total number of automatic switch operations necessary for the correct clearance of trouble. (Includes the correct number of switches which should have kicked out in order to clear the trouble from the system.)	54	11	6	21	22	114	100
2. Total number of automatic switches which operated correctly to clear the trouble on the voltage concerned. (Includes the operation of all switches tripped out by over-voltage or under-voltage relays.)	54	11	4	20	20	109	96
3. Total number of unnecessary automatic switch operations. (Includes all switches which tripped out incorrectly at time of trouble. Operations due to unknown trouble may be considered as correct.)	12	3	0	16	0	31	27
4. Total number of automatic switches which failed to operate. (Includes all switches which did not trip but should have tripped in order correctly to clear the trouble.)	1	0	2	0	2	5	4
5. Total number of automatic switch operations. (Includes every switch operation, 11-kv., or above, that appears to be caused by some case of trouble. Trip-outs of switches when closed in on test are included; operations due to trouble in control equipment and relays are included; accidental trips or switches dropping out due to mechanical trouble are not included.)	66	14	4	36	20	140	123
Causes of failures							
Of the unnecessary operations:							
Synchronous machines falling out of step	10	0	0	3	0	13	
A. C. trips failed or delayed in operation*	1	0	0	0	..	1	
Improper relay setting	0	1	0	10	0	11	
Failure of control wiring	0	2	0	1	0	3	
Failure of battery on 11 kv.	0	0	0	1	0	1	
Failure of CO relay	1	0	0	0	0	1	
Unexplained operation of CR relay	0	0	0	1	0	1	
Of the switches failing to operate:							
Failure of battery	1	0	0	0	0	1	
Failures unexplained	0	0	0	0	2	2	
Improper relay setting	0	0	2	0	0	2	

*All plunger relays and series trips are included under "A. C. trips." Failure of any piece of equipment is recorded only when found so by results of test or proper inspection.

tirely removed, thereby lowering the dielectric strength of the oil.

One transformer manufacturer has overcome the objections outlined above by developing a radiator of such sturdy construction that it can be welded to the transformer tank at the factory and the transformer shipped complete with all oil in the transformer and radiators, thereby eliminating the trouble and expense of installing radiators and handling oil in the field. This radiator is of rugged construction, yet light in weight. It is made from copper-alloy steel approximately twice as heavy as the steel used in the ordinary tubular-type radiator. There are no pockets or crevices either inside radiators are accessible on all sides for cleaning and painting without removal from the tank.

This radiator offers maximum cooling efficiency. It is about twice as efficient as any transformer radiator heretofore produced and permits the shipping of transformers built as large as 15,000 kva., self-cooled and complete with oil and radiators installed, on standard railroad cars. Units up to 20,000 kva., self-cooled, can be shipped complete with oil, and radiators attached permanently, by using drop-bottom cars.

Power Interchange

This is a topic upon which there has been much interesting discussion as to the various means by which interchange of power is made possible. The year just past no doubt witnessed the largest interconnection of different power companies ever consummated. The experience gained with this great interconnected net work has been very valuable to all of the various utility companies as there have been the many questions of various frequencies and voltages to be met.

The following reports from member companies on this subject are submitted and appear in full later in this report:

"Frequency Changer Operation," by L. L. Dyer and E. R. Stauffacher; "Power Interchange in San Joaquin Valley in 1924," by R. D. Likely; and "Pacific Gas and Electric Company Power Interchange,"by H. T. Sutcliffe and B. D. Dexter.

Relays and Relay Application

The proper operation of any system and especially a net-work system of transmission lines is so closely related to the proper functioning of the relays and protective devices that no study of electrical apparatus is complete without careful consideration of the many relay problems involved. Such a study has a direct bearing upon reduction in investment and operating costs. The proper functioning of relays results in very great savings by preventing damage to equipment and eliminating hazards and also increases revenues by preventing unnecessary system interruptions by reducing any interruption to the particular line or station involved in the disturbance. Then, too, the proper application of relays permits the operation of a transmission system particularly a net-work system, to derive the greatest benefit from the carrying capacity of the line conductors by having such a system completely tied together through the net work. This gives diverse feeds into certain stations and assures that any trouble will be taken care of by the proper functioning of the relays on the lines involved.

Therefore the apparatus bureau during the past year has spent much time in the consideration of the topic of relays and relay applications. There has been some discussion as to the necessity for definite specifications for relay operation that records may be kept of each operation. The following classification is suggested:

(1) Correct operations
(2) Incorrect operations
(3) Unnecessary operations

These operations are to include the action of the oil-circuit breaker involved. As to whether it is proper to include the action of the oil-circuit breaker in relay operation is no doubt open for discussion. In any event if improper oil-circuit breaker operation occurs, as it does on most systems, then greater attention must be paid to the overall testing and maintenance of both relays and oil-circuit breakers as either, without the proper functioning of the other, is useless.

Several of the member companies are keeping records of the operation of their relays for further study. The Southern California Edison Company has devised a card system known as "Protective Equipment Record" which is used with cards of four colors as follows:

Blue, for 220 kv. and 150 kv.
Salmon, for 60 kv. and 30 kv.
Cream, for 15 kv. and 11 kv.
White, for all below 11 kv.

These cards all carry the same data and are arranged to carry information on both sides. Fig. 2 shows one of these cards.

The value of the information which may be derived from the study of relay operation is illustrated in Table II, the original of which was submitted by E. R. Stauffacher of the Southern California Edison Company. A report similar to the one shown is drawn up monthly and yields much valuable information.

New or Unusual Applications of Relays

Under this heading it is believed that a general statement of the practices developed by various Western engineers for the protection of intricate transmission net works will be pertinent and of general interest. Several different methods of application of standard and modified-standard relays are in use by the different companies. Papers covering this subject have been prepared and appear in full later in this report. These papers are: "Relays and Relay Application," by R. C. Denny; "New Types of Protective Relays," by H. T. Sutcliffe, R. W. Wilkins and H. S. Lane; "Relay Protection as Applied to a Large Transmission Network," by R. W. Wilkins.

Relative to the subject of relay protection is the subject of the calculation of short-circuit currents. A knowledge of at least an approximation of the amount of current delivered over certain lines under conditions of stress is essential to the intelligent application and setting of relays. Measurements in this case are impossible and calculations impracticable. Hence most power companies of any size have built up a "dummy" system on a small scale. From the "dummy" current deliveries under conditions of trouble may be determined with acceptable accuracy. A description of the "dummy" system, or "calculating board," as it is called, used on the San Joaquin system is given by R. C. Denny in his paper "Design and Application of System Calculating Board," appearing in full later in this report.

New Equipment

The bureau is interested in following the installations of electrical equipment as they are made. By thus following the latest applications of new equipment much information of interest and value to members and member companies may be derived. "Switchboard Instruments and Wiring" by Roy Martindale is published later in this report and gives a description of the metering installation at the new Hollywood substation of the Los Angeles Bureau of Power and Light.

There has been heavy demand for an inexpensive type of high-voltage current transformer suitable for relay operation and also metering. The characteristics of the bushing type of current transformer are such as to be unfavorable for this latter type of service. There has been developed by a Pacific Coast manufacturer, the Pacific Electric Manufacturing Company, what is known as the meter type transformer which is manufactured for service at 35-45 kv., 60-73 kv. and 125-132 kv. This transformer is mounted immersed in oil of the oil-circuit breaker. A paper on the "Characteristics of Pacific Electric Manufacturing Company Meter Transformers" appears in full later in this report.

Automatic Stations and Equipment

There has been a very consistent increase in the application of automatic reclosing equipment to substations and the results attained have been beyond the expectations of those who recommended their installation. One of the first companies to install automatic substations was the San Joaquin Light & Power Corporation and the report submitted by E. K. Sadler, "Automatic Substations on the San Joaquin and Affiliated Systems," appearing in full later in this report gives some interesting information covering these installations.

Automatic substation installations being made on the system of the Pacific Gas and Electric Company are covered in a paper by R. B. Kellogg, H. T. Sutcliffe and B. D. Dexter on "Design and Operation Features of Automatic Substations," appearing in full later in this report. "Design of Automatic Regulator Heads," by

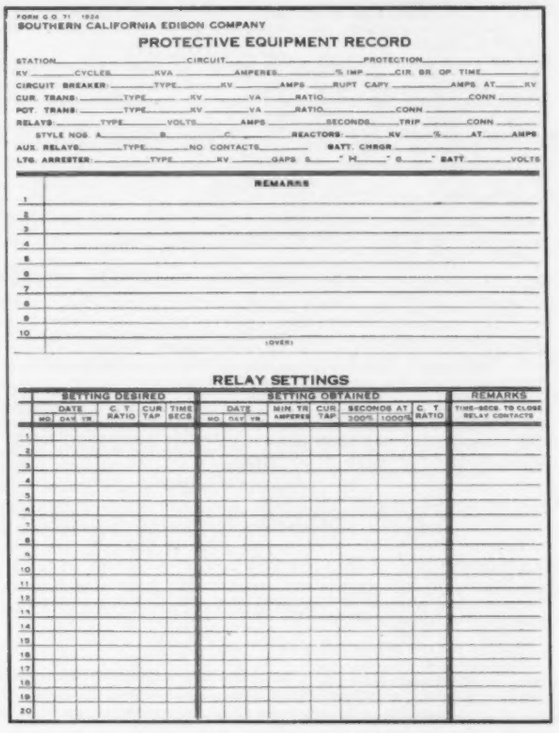

FORM G.O. 71 1924
SOUTHERN CALIFORNIA EDISON COMPANY
PROTECTIVE EQUIPMENT RECORD
STATION_____CIRCUIT_____PROTECTION_____
KV_____CYCLES_____KVA_____AMPERES_____% IMP_____CIR. BR. OP. TIME_____
CIRCUIT BREAKER: _____TYPE_____KV_____AMPS_____RUPT CAPY_____AMPS. AT_____KV
CUR. TRANS: _____TYPE_____KV_____VA_____RATIO_____CONN_____
POT. TRANS: _____TYPE_____KV_____VA_____RATIO_____CONN_____
RELAYS: _____TYPE_____VOLTS_____AMPS_____SECONDS_____TRIP_____CONN_____
STYLE NOS A_____B_____C_____REACTORS_____KV_____% AT_____AMPS
AUX. RELAYS_____TYPE_____NO. CONTACTS_____BATT. CHRGR._____
LTG. ARRESTER: _____TYPE_____KV_____GAPS S_____" H_____" G_____" BATT._____VOLTS
REMARKS
1 2 3 4 5 6 7 8 9 10
(OVER)
RELAY SETTINGS
SETTING DESIRED: DATE (MO. DAY YR.), C. T. RATIO, CUR. TAP, TIME SECS
SETTING OBTAINED: DATE (MO. DAY YR.), MIN. TR. AMPERES, CUR. TAP, SECONDS AT 200% | 1000%, C. T. RATIO
REMARKS: TIME-SECS. TO CLOSE RELAY CONTACTS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Fig. 2—Showing (above) the face and (below) the reverse side of the protective equipment record card used by the Southern California Edison Company. This card supplies a continuous record of all changes in relay settings or of other like equipment in the order in which they are made.

J. L. Landon, appears in full later in this report and gives some interesting information on that subject. "Some Features of Automatic Generating Plant Design and Operation," by R. C. Denny, appears in full later in this report.

Station Electrical Grounds and Control of Grounds

Great interest is manifested in this subject and much study has been given toward the improved efficiency of grounding systems. Pertinent to this are the efforts toward the actual measurement of the resistance of the ground return circuits between stations. Greater care should be taken not only to secure better grounds, but frequent tests and inspections should be made to determine the value of such grounds as established.

Papers on this subject following later in this report are "Ground Current Control and Station Electrical Grounds," by F. H. Mayer, D. J. Kennelly and H. L. Sampson; "Station Grounds on the San Joaquin System," by H. N. Kalb; and "Station Grounds on Pacific Gas and Electric Company System," by B. D. Dexter, H. S. Lane and H. T. Sutcliffe.

Fire-Fighting Methods and Equipment

This topic is one which vitally concerns all operating men of public utilities as there always is the hazard of failure of oil-filled apparatus, generating equipment, etc., any of which may result in serious fires, crippling the plant output and creating great damage. Many schemes have been evolved and put into successful operation for the protection of generating equipment by the use of closed systems of ventilation, dampers in air ducts, differential relay protection to immediately

disconnect machines from the line and from field excitation and the use of water, steam, carbon dioxide or carbon tetrachloride for putting out such fires which once started.

The committee this year has studied the many angles of proper fire-fighting equipment and the failures of oil-filled apparatus hoping to profit very materially from them.

The following reports are submitted: "Fire-Fighting Equipment Used by L. A. Bureau of Power and Light," by H. H. Cox; "Fires Caused by Failures of Oil-Filled Apparatus," by H. A. Laidlaw; "Fire-Fighting Practices of San Joaquin Light & Power Corporation," by J. M. Buswell; "Fire-Fighting Equipment and Experiences of the Edison Company," by J. C. Gaylord, H. L. Sampson and L. L. Dyer; and "Fire-Fighting Apparatus at Long Beach Steam plant No. 2."

Suggested Program for Ensuing Year

There are many topics each year which in themselves are desirable for study by this committee, but which may not be of interest to the greatest number of those on the committee. In order to determine subjects of interest with the least possible delay, careful consideration was given to these topics at the Fresno meeting and the following were agreed upon as a recommended program for the coming year. This is of course subject to change should the incoming chairman so desire.

(1) Pacific Coast practices in transmission and distribution substations. This should be the major topic.

(2) Tests of station grounds. Further information on this subject is very desirable.

(3) Oil-circuit breakers
  (a) Report of any tests which may be conducted by Pacific Coast companies.
  (b) Gather data and study oil-circuit breaker operation through a special committee in conjunction with the member companies in the use of form adopted by apparatus bureau at Fresno meeting.

(4) Review of transformer voltages in conjunction with the overhead systems committee.

(5) Relays and relay application
  (a) New types of relays for the protection of transmission net works.
  (b) New types of relays for the protection of internal trouble in equipment.
  (c) New or unusual application of older types of relays.

(6) Lightning arresters.

(7) High-tension fuses.

(8) Carrier-current telephone communication. (This last topic not definitely decided upon.)

In the carrying forward of the work of the apparatus bureau for the ensuing year, the chairman can ask nothing better for the incoming chairman than that the same cooperation be extended to him that has been given to the chairman this year.

The activities of the committee are wonderful clearing houses of information, for good fellowship and for the "rubbing of elbows" with the men of the industry. For all of these and for the wonderful cooperation the chairman is deeply grateful.

Increasing Oil-Circuit Breaker Interrupting Capacity

By H. H. Cox

THE development of the oil circuit breaker in southern California dates back almost to the beginning of oil switches. Oil switches first were made locally because the operating companies had to have something better than ordinary knife switches. Later, locally made oil switches came to be quite extensively used for two reasons. First, because they could be obtained cheaply. Low first cost was quite essential for many of the pioneer extensions. Second, because they could be obtained much quicker than from Eastern factories.

About twelve years ago the problem of interrupting capacity was encountered. Due to the growth of the generating plants, switches began to fail. This problem first was met by increasing the physical size of the switch, larger tanks, longer breaks and contacts deeper in oil. The next step was changing from two breaks per phase to four breaks. This change so increased the interrupting capacity that for several years everything was all right. Finally, four break switches began to fail and the next step was the development of the six-break switch. Again the problem was solved for a few years and then the six-break switches began to fail by bursting their tanks, throwing oil and in other ways demonstrating their inadequacy. Up to this time all tanks had been rectangular and of fairly light sheet metal. It was seen that rectangular tanks would not stand the internal pressures developed. The next step

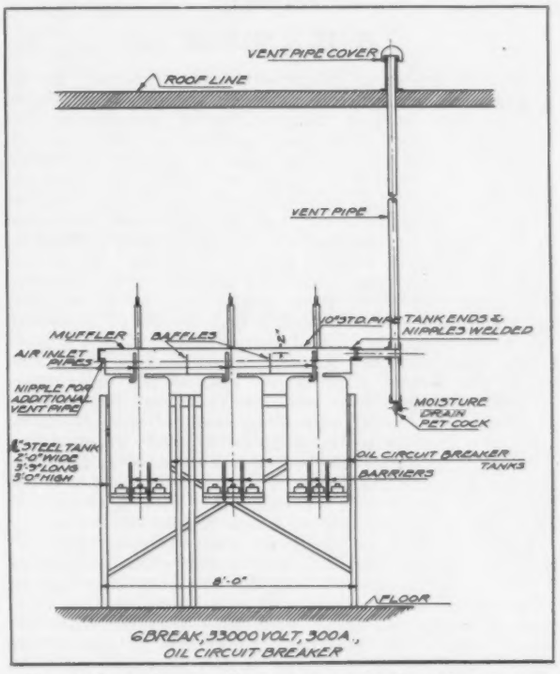


Fig. 1—Semi-schematic diagram of a 6-break, 33-kv., 300-amp. oil circuit breaker showing the explosion header and the vent pipe which carries the gases to the roof.

was to make the tanks into a form which would withstand internal pressure. This produced a cylindrical tank with a rounded top and bottom of heavier sheet steel, all seams being welded. A manhole cover on the top held down by coil springs provided a relief valve to reduce excessive internal pressure.

Today there are operating in southern California six-break switches of this type which are interrupting successfully 33-kv. short circuits of 750,000 kva. and 66-kv. short circuits of even greater volume. A few of these switches have been made having ten breaks per phase. However, the tendency at the present time seems to be to stick to the six-break switch and strengthen the tank rather than to use the ten breaks.

In rebuilding some of the older switches and in some new switches which are to be used indoors and in limited space it was not possible to utilize the round tank idea, consequently the nearest possible approach to it is used. Oval tanks with specially-reinforced sides and bottom of heavier plate and with cast-steel tops are proving successful. Particular attention has been given to the tank welding in order to gain all possible strength. Realizing that a high pressure is produced in a breaker during the period of interrupting heavy short circuits and that considerable gas is generated from the decomposition of the oil by the arc, it was decided to be impractical to try to make the tank strong enough to hold under all circumstances. Consequently means were designed whereby this pressure could be relieved. This has resulted in a manifold extending across the three tanks of a switch that acts both as a relief space and as oil separating chamber. This manifold is vented to the outside of the station building. The vent is carried outside because the gas generated in a switch is almost pure hydrogen and is highly explosive when mixed with air. An illustrative sketch of this switch is shown in Fig. 1 which will give the general details of design. The vent pipe is 2-in. or 3-in. iron pipe.

On some of the switches upon which was first tried the venting scheme a 3-in. pipe manifold was used with a single vent pipe. This proved inadequate and was later replaced by running a separate 3-in. vent pipe

direct to the outside of the building from each tank. So far this has proved successful for the interrupting duty required in that particular location.

Fig. 1 shows a six-break switch arranged with external vent.

Oil-Circuit Breaker Experiences and Problems

By H. S. MINOR

OF "Progress in Higher-Voltage Breakers" to increase the rupturing capacity, the means employed by the various manufacturing companies are familiar to most. The more common of these are: increase in speed of break, increase of number of breaks, increase in strength of tanks and parts, vents for the handling of oil and gas pressures, and other similar advances. It is believed that we are more interested in the operating experiences and installation difficulties encountered with various type of switches. These experiences of the San Joaquin Light & Power Corporation show that all of these points must be given careful thought when considering the design of a switch. We have used one line of oil switches with a higher rating than switches formerly used that do not stand up to the service required as well as the older type. Several of these newer switches have been bent all out of shape on several occasions, most of the oil blown out and a bad service interruption caused. In changing the design the tanks had been made stronger and deeper, the break occurring under a greater depth of oil, but the top of the switch was not made strong enough to take care of the strains to which it was subjected.

The same line of switches was equipped with an improved type of operating mechanism which has proved to be so delicately set that the switches trip out on many occasions when no trouble is found on the lines, these interruptions being much more frequent with this newer type. The operating mechanism is one of the most important parts of the switch gear and must be made rugged and dependable. Some switches are found where it is necessary to work over the parts of the operating mechanism before the switch will function properly. On some outdoor switches the mechanism has not been housed properly and after being exposed to the weather for some time has failed to operate. On still other switches where the operation has not been satisfactory a factory man has been sent out on the job and a few newly designed parts added.

We have also several switches of large carrying capacity which run hot when subjected to about 75 per cent or less of their nomal ampere rating. On some occasions it has been necessary to install a ventilating system to keep the switch cool enough to be operated safely.

There seems to have been too great a tendency for the manufacturing companies both large and small to build something in the way of an oil switch and try it out on some power company's system and later attempt to improve it if not satisfactory. Only during the last few years has any attempt been made to subject switches of different design to tests of the conditions under which they are supposed to operate.

Practically all of the distribution outside of the larger towns and cities within the company's territory is at 11 kv. Until within the last few years at most of our substations these lines radiated from indoor type oil switches which have been housed in wooden frame corrugated iron buildings with concrete floors. These buildings have been satisfactory for the size stations for which they were built but as the loads increase and the transformer installation is increased it becomes necessary to consider cell structures and isolation of phases in order properly to provide the rupturing capacity needed. In some of the larger substations the company has used this form of construction. In others an outdoor type switch supported on a pipe structure has been used. It is found that the outdoor type of substation is much cheaper than the fireproof building and cell structure equipment which it replaces. The company has believed that it is just as satisfactory and operating experience bears this out. It is hard to find on the market many outdoor type oil switches of great rupturing capacity which are built for 11 kv. service.

Rupturing capacity becomes a more and more important consideration as the load on a system grows. When the transformer installation at a substation is increased it soon becomes necessary also to increase the size of the oil switches. The same condition exists when considering the switches on the transmission system. Sometimes it is difficult or impossible to utilize the smaller switches which are being removed from service. It was necessary to face this sort of a problem

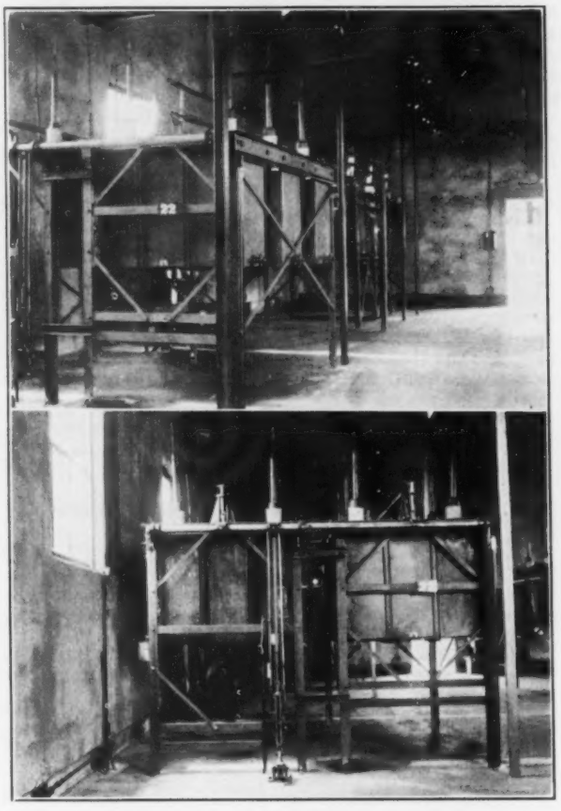


Fig. 1—Showing two 2-break oil circuit breakers built together to form one 4-break oil circuit breaker.

when considering the switch equipment at Power House No. 1 and at Copper Mine Substation. These two statiions had been connected by two 60 kv. trunk lines of small wire which are being replaced by a tower line supporting one circuit of heavy conductor. All of the switches in service were 60 kv., two-break, indoor-type, and had thrown oil on several occasions. At times considerable damage had been caused. Switches of larger rupturing capacity were needed.

At the Copper Mine Substation there are four 60-kv. lines including the new line to P.H. No. 1. To install four outdoor type 60-kv., four-break oil switches with disconnects, buses, etc., mounted on steel structures would cost $25,000. This would leave six of the indoor-type, two-break oil switches on hand and a fire-proof building 30 ft. x 70 ft. for which there would be no particular use. The idea of making a four-break switch out of two of the two-break switches was considered and it was found that two of the switches could be tied together mechanically in a satisfactory way so that they would operate as a four-break switch. The expense was less than $50 for each pair of switches. By installing one additional four-break switch and using the six two-break switches in three sets of two it was possible to equip each of the four lines with a four-break switch. The cost of this installation is about $10,000, a saving of $15,000 effected by using the equipment in this manner. There have been several interruptions since these rebuilt switches were placed in service, all of which were handled without any difficulty. Fig. 1 shows an example of this reconstruction.

Similar switches had been in use at Power House No. 1. The switches are solenoid operated while those at the Copper Mine Substation were hand operated. Here the switches are installed in a long narrow switch

gallery and it was not possible to place two of these switches side by side as was done at the substation. Instead they were placed end to end. Bell crank supports were reinforced and the throw of the pallet switch adjusted so that the same operating solenoid could handle the four-break switch. The cost of this job was not over $10 for each set of switches. There are two 60-kv. lines to take care of at the power house and the cost of an outdoor installation of new four-break switches would be about $12,500, while the installation inside the building using the old switches cost about $2,500. It would have cost about $9,200 to install two new four-break oil switches inside the building.

The company has used transformer oil in oil switches in place of approved switch oil at a saving of about

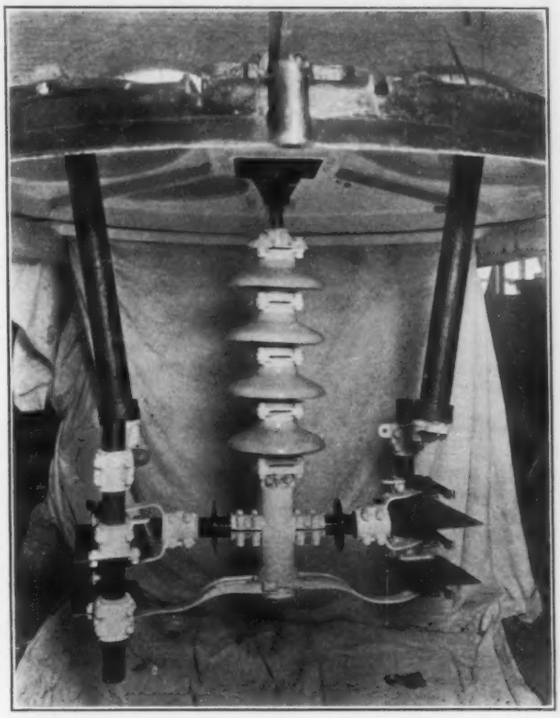


Fig. 2—Showing mechanism of 6-break oil circuit breaker manufactured by Pacific Electric Manufacturing Company of San Francisco.

25 per cent in the cost of the oil and has had no operating difficulties with it.

As yet no means of interlocking the disconnects used in connection with oil switches has been developed.

Tests have been made with a cycle counter on the speed of opening of oil switches. This disclosed a variation of from 6 cycles to 17 cycles in the time required from trip to the point where the blade leaves the clip and a variation of from 12 cycles to 15 cycles from the beginning of opening to the end of stroke.

According to one of the manufacturers of oil circuit breakers distinct progress in the design and manufacture of oil circuit breakers in the higher voltages has been shown, especially with regard to ease of installation, maintenance and operation mechanisms. The General Electric Company, which manufactures oil circuit breakers with explosion chambers, has embodied in some of its present standard lines of these breakers an improved-design explosion chamber, which makes it unnecessary to remove the explosion chamber when installing new contacts, where this removal formerly was required. This improved design materially cuts down the out-of-circuit period of an oil circuit breaker for the purpose of changing contacts.

Regarding ease of installation, actual experiments have been made by the General Electric Company with breakers crated and braced on freight cars to determine whether or not it would be practical to ship triple-pole breakers in one unit, thus requiring no re-assembly at the point of installation. These experiments have been very successful and the company now ships oil circuit breakers up to and including the 73-kv. size as a unit so that the three poles may be simultaneously mounted without any re-assembly. Of course the solenoid or motor mechanism must be attached to the finished framework after its installation.

Further improvements have been made in the higher-voltage breakers by the installation of separating chambers. The breakers themselves have been made oil and gas tight so that the only exit for gas is through the separating chamber. The function of the chamber is to minimize oil throw, to condense oil vapor formed by contact of arc and oil during an interruption and to cool the arc gas before it is discharged into the atmosphere.

It is true that the interrupting capacity of a breaker depends upon the speed of the break, but it does not follow necessarily in every case that the higher the speed the greater the interrupting capacity. The interrupting capacity of a breaker depends upon not only the quantity of gas generated, but also upon the speed of generation. Therefore it may be possible and quite likely that a given breaker if operated at a higher speed will have less interrupting capacity. The General Electric Company has observed from numerous tests that for a given breaker a higher operating speed may well be expected to result in a longer arc, more gas, and more pressure than would result from a lower operating speed. Therefore it becomes necessary to know a great many other factors relating to the particular design of breaker in question in order to determine whether or not a higher speed would have any advantageous effect upon the interrupting capacity. All of the foregoing, relating to the speed of break, is based upon the assumption that the moving contacts will travel at practically uniform speed. As a matter of fact, however, every breaker will have its own speed characteristic and this characteristic at no load may be decidedly different from the speed at full interrupting capacity. In fact, at some particular load the action may not only slow down, but actually stop and reverse in direction so as to reclose the breaker. There are several reasons for this behavior and one of the plain-break breakers can be considered as entirely unaffected by it. Whether or not the defect is a serious one in any particular case can be determined only by actual test of the breaker under severe operating conditions.

In the case of fairly low-voltage breakers operating to interrupt large current, the actual speed of the moving contact may have little relationship to the interrupting capacity of the breakers as such breakers interrupt the arc by the magnetic-blowout effect instead of by physical separation of contacts. It may be found, however, that the heaviest stress is not produced by the largest current interrupted and that more gas and greater pressure is produced when interrupting smaller currents. This fact must be considered in the rating of the breaker.

The necessity of employing an adequate muffler or separating chamber on oil circuit breakers to eliminate as far as possible the escape from the breaker tanks of oil and gas is apparent in view of the increasing number of specifications calling for these devices. The separating chamber developed by the General Electric Company for outdoor breakers consists of an iron pipe with a 180 deg. elbow at one end and a screen on both ends. This pipe is filled with quartz pebbles and has been given many thousands of tests. Other mufflers or separating chambers also were tested, but the present design proved to be superior. This chamber has been in actual service for over two years and functions as intended, there being no escape of gas or oil. The oil vapor which is forced into the chamber along with the gas is condensed on the surface of the pebbles and returns to the oil tank. At the same time, the gas passes through the quartz stack, being cooled in passage and finally exhausted into the atmosphere.

The design for indoor breakers is quite similar except that for the "H" type the chamber consists of an insulating material. The design and operation, however, is exactly the same as described for outdoor breakers.

It is the recommendation of the manufacturer that a header be used for a group of indoor breakers, the number per group to depend upon the size of the header and the severity of the service. It is believed that it will be found that generally ten or twelve breakers can be connected to one header of ample size. Should the

total number of breakers exceed twelve a second header is recommended.

By all means it is advisable to extend the header and exhaust the gas out of doors. However, in stations where there is ample head-room there is no objection to exhausting each breaker or groups of breakers directly into station. When this is done care must be taken that the end of the exhaust pipe is beyond any line-buses or breaker-mechanism parts where there is likelihood of a spark. The gas as it is exhausted becomes explosive when combined with sufficient oxygen from the atmposphere. Diffusion is so rapid that no explosion can take place after the gas has been exposed to the atmosphere for a few seconds.

A Pacific Coast manufacturer of oil-circuit breakers states that "The Pacific Electric Manufacturing Company has in operation a large number of the new six-break design of oil-circuit breakers and the operation of these has been very carefully checked up by reports from the operating companies and as unfavorable comment or apparatus failure is very much more likely to become known to the manufacturer, it is believed

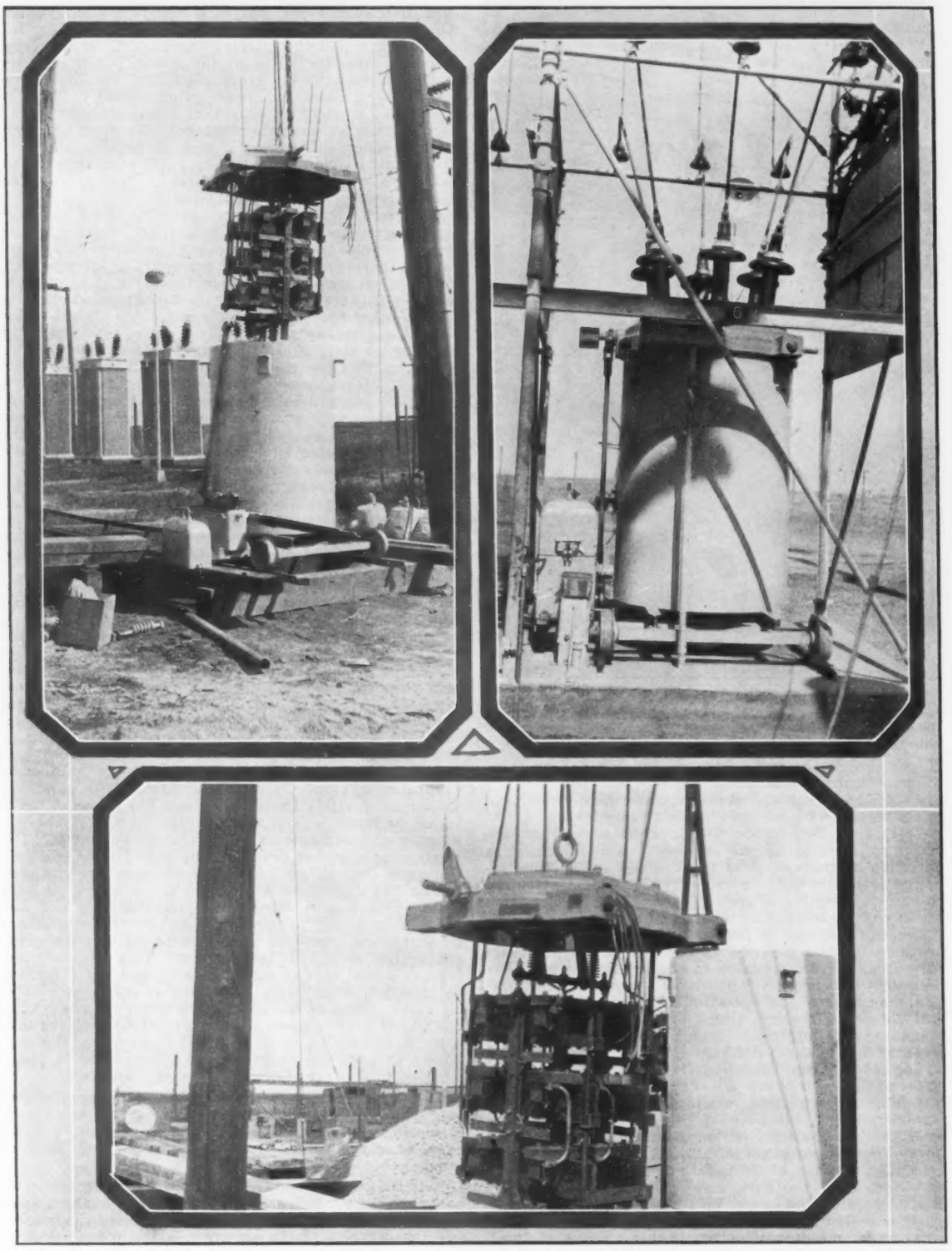


Fig. 3—Several views of type F-6, 300-amp., 15-kv. breaker manufactured by Kelman Electric & Manufacturing Company, Los Angeles

that the lack of any such comment indicates that these breakers are fully meeting the requirements. These breakers are being made for voltages up to 135 kv. and may be six-break or more as the six-break, horizontal, rotating design as developed permits the addition of breakers by duplication of the parts in multiples of four so that ten-break or fourteen-break switches can easily be built, using parts now used in the six-break design." Fig. 2 shows the six-break mechanism assembled on "dummy" supports in lieu of insulators.

Another Pacific Coast manufacturer, the Kelman Electric & Manufacturing Company, also manufactures multi-break oil-circuit breakers of the pantograph type so arranged that the number of breaks can be increased up to ten per phase for voltages up to 135 kv. This company also has developed a six-break, three-phase, outdoor, round-tank type oil-circuit breaker for 15 kv. service in which all three phases are in the same tank and separated by suitable barriers. This breaker may either be suspended from a suitable switch structure or mounted on trucks as desired. It also is equipped with bushing-type current transformers. Fig. 3 shows some of the details of this most interesting breaker known as the Kelman Type F-6.

With the increase in capacity of breakers there has been an increase in size and weight of moving parts and the effect of increase of inertia in these moving parts must be given serious consideration. Efforts must be directed toward refinements in the operating mechanism in order to maintain proper operating speed. Roller bearings, universal joints and other similar developments in the operating mechanism of very large breakers are desirable where they increase the operating speed.

Rating of Oil-Circuit Breakers

The subject of rating oil-circuit breakers is one which vitally affects the operation of all power companies. The function of operating companies is to give service and of the manufacturers to furnish the necessary equipment. Duties of breakers are becoming increasingly severe and breakers must meet these conditions as a reasonable cost. The present cost of high tension breakers is very large. Systems can not be built around breakers nor service curtailed because of breaker limitations. Better breakers are needed.

A few paragraphs from the report of the a.c. substations subcommittee of the Electrical Apparatus Committee, N.E.L.A., Mr. E. C. Stone, chairman, very nicely summarized this problem.

Results of Tests on Oil-Circuit Breakers of Pacific Coast Manufacture

IN order that information might be made available concerning the capacity of oil-circuit breakers manufactured on the Pacific Coast the following reports covering tests already made are submitted.

The Pacific Electric Manufacturing Company submits the following information covering tests of a six-break oil-circuit breaker, solenoid control, automatic release:

A 66-kv. six-break Pacific circuit breaker was installed at a large central switching station that its action might be observed while it was protecting the circuit during the testing of various types of fuse tubes. The circuit breaker operated ten times, interrupting the circuit when the arc from the fuse tubes failed to rupture.

It then was given three tests on direct short circuit. The first test with one single power house on the line caused so little evidence of disturbance that the circuit breaker then was connected to the main distributing lines, supplied by five large power houses and several smaller ones, and was operated twice on short circuit.

The oscillogram shown in Fig. 1 is that taken during the last short circuit operation. In the oscillogram, line "A" is the direct current tripping coil circuit, line "B" is the line current record reading approximately 1,500 amperes after the first cycle, and line "C" is the 60-kv. bus voltage. A time element relay was connected in the tripping circuit and this relay was operated from current transformers built into the circuit breaker.

It will be seen by reference to the oscillogram that the time limit relay connected the tripping coil during the fifth cycle after the short circuit was established. A period of sixteen cycles then was consumed in the mechanical operation of tripping, moving the blades clear of the contact arcing tips and drawing the arc.

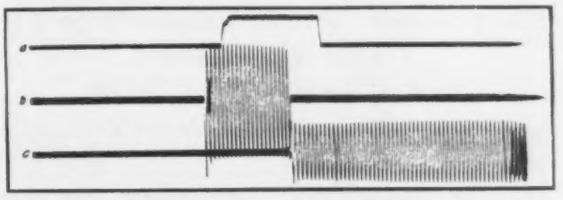


Fig. 1—Oscillogram of short circuit test of Pacific Electric 66-kv. 6-break oil circuit breaker.

About six cycles thereafter the mechanism opened the tripping coil circuit. At the time of opening the tripping coil circuit, the blades of the circuit breaker and the actuating mechanism had not entirely completed their travel by about five cycles. The whole operation of short circuit, rupture and reestablishment of potential consumed a period of 30 cycles.

Interrupting Capacity of Oil-Circuit Breakers Manufactured on the Pacific Coast

By C. C. LONG and L. L. DYER

NO laboratory or special tests ever have been made by the Southern California Edison Company to determine the interrupting capacity of circuit breakers purchased from Pacific Coast manufacturers excepting the tests on the Kelman type Y15 switch described in another report. However, it may be of interest to have some data on certain installations where these breakers have been used satisfactorily. This should be of benefit to others contemplating the use of the same type of breakers.

The Kelman type CB70, four-break, 70-kv. switch was installed in several substations about four years ago. At Vestal substation these breakers are in the 60-kv. line connecting to a bus fed by a bank of 34,500-kva. transformers from the 150-kv. bus which in turn is fed by means of auto transformers from the Big Creek 220-kv. transmission lines. Two substations of 30,000-kv. transformer capacity use these switches in lines connected into the 60-kv. network around Los Angeles. The computed short circuit current at the 60-kv. buses of these latter two substations is approximately 6,500 amp. So far these four-break switches have performed satisfactorily except for bulging the sides of the square tanks when operated under heavy short circuits. Because of this defect no more of this type are being installed.

At Laguna Bell the 60-kv. circuits are handled by Kelman type D6 switches which have given satisfactory service for two years. This 60-kv. bus is fed from the 220-kv. Big Creek transmission lines through two banks of 60,000-kv. transformers. A 30,000-kva. synchronous condenser through a 30,000-kva. bank of 60/6.6-kv. transformers adds to the duty on these breakers. The computed short circuit on this 60-kv. bus is around 13,000 amperes. To date the 60-kv. breakers never have been called upon to clear a close-in short circuit.

The Kelman type F6 switches have been used on 10- and 15-kv. circuits for something over a year. The most severe conditions under which they are operating are at Signal Hill and Santa Fe Springs substations. Here they are tied into the system through short 60-kv. transmission lines to Long Beach steam plant and Laguna Bell respectively. At each place the low-tension bus is fed by one bank of 9,000-kva. transformers, 60/11 kv. On heavy short circuits they throw some oil and blister their main contacts but so far there have been no failures chargeable to the switches themselves. At these two substations the computed short circuit current is about 6,500 amp. at 11 kv. These

breakers have opened short circuits on lines close to the substation at both places.

While these figures do not indicate the maximum interrupting capacity of the breakers, they give some idea of the installations in which they have proved satisfactory.

Short Circuit Tests on Kelman Type Y15 Oil-Circuit Breakers

By C. C. LONG and L. L. DYER

THE tests described were made on two Kelman type Y15 switches at the Katella substation of the Southern California Edison Company on Jan. 6, 1924. Two switches of this general type were used. One was of standard Kelman manufacture, while the other had been equipped with an auxiliary device called an "arc chopper." This device consisted of a fiber barrier so arranged that when the switch opened this fiber barrier was forced between the stationary contact and the movable switch blade by means of flat springs, thus cutting into the path of the arc that might pass between the blade and the contact.

Short circuit current for the first six tests was obtained from the substation equipment. A 10,000-kva. 11-kv. synchronous condenser was connected to one of the station buses. The circuit containing the switches under test was connected to this same bus through a circuit breaker of large rupturing capacity. This circuit was short-circuited on all three phases and equipped with current and potential transformers the secondaries of which were extended to a recording oscillograph. The Kelman circuit breakers under test were equipped with series tripping coils, standard equipment for this type of switch. The following method of test was used:

With the circuit breakers under test closed and the large circuit breaker connecting them to the bus open, the bus was energized from the main substation bus and the condenser brought up to speed. The test bus was then separated from the main station bus leaving the condenser floating on the test bus. Condenser voltage was quickly lowered to the required value and the main breaker closed, throwing the short-circuited line onto the condenser bus. As this all was quickly done before the condenser had time to drop much below synchronous speed it was possible to obtain the effect of a short circuit thrown upon a 10,000-kva. generator at the desired voltage. As this generator was of high internal reactance no damage could be done to the windings. No system disturbance could be caused because all test circuits were separated from the system at the time of application of the short circuit.

TABLE I.—Summary of tests on Kelman Y15 switches.

Test No.	Cond. volts	Short circuit amp. approx.	Short circuit amp. computed	Short circuit amp. at 11 kv.	Comment
1	6,000	1,000	No film	.....	Little smoke—no oil thrown.
2	5,000	900	515	235	No smoke—no oil thrown.
3	9,000	1,500	1,530	1,250	Little smoke—little oil thrown.
4	8,500	1,400	No film	.....	Little smoke—little oil thrown.
5	11,000	2,300	1,360	1,360	More smoke—1 pt. of oil thrown.
6	11,100	2,400	1,960	1,960	Lots of smoke—1 pt. of oil thrown.
7	11,200	over 6,000	No film	.....	Switch failed to open—exploded and caught fire.

On test No. 7 the circuit containing the Kelman circuit breakers was thrown directly into the station bus. This bus was connected through a 15,000-kva. bank of transformers, 60/11 kv. to a 60-kv. line running directly to Laguna Bell. The 10,000-kva. condenser was disconnected for this test so that the short circuit current interrupted was that from the Edison system through about 30 mi. of 4/0, 60-kv. line and one 15,000-kva. bank of transformers.

In Table I is shown the value "short circuit amperes approximate" which is the reading taken on an ammeter in the circuit of the oscillograph vibrator. The value "short circuit amperes computed" is the effective value of current obtained scaling the current waves on the oscillograph films. The oscillograph had been calibrated before the test. This value is taken at the cycle in which the breaker started to open. In order to get a comparison between tests No. 2 and No. 3 and Tests No. 5 and No. 6 the values of "short circuit current computed" are reduced to the same condenser voltage by assuming that the duty on the breakers is directly proportional to the terminal voltage.

Tests Nos. 1, 3, 5 and 7 were made on the Kelman switch equipped with "arc choppers" while Tests Nos. 2, 4 and 6 were on the switch not so equipped.

Conclusions

No definite conclusions can be made as to the maximum amount of short circuit current which this switch will interrupt because not enough data was taken. Indications, however, are that the switch would satisfactorily handle 1,500 amp. at 11 kv. As far as could be determined the "arc choppers" were of no benefit. In fact the switch so equipped and used in Test No. 7 was badly damaged, the "choppers" being broken off by the force of the arc. However, this test was much more severe than this switch ever was intended to handle and no result other than that obtained could be expected.

High-Tension Oil-Circuit Breakers

By R. W. WILKINS, B. D. DEXTER and H. T. SUTCLIFFE

NO radical changes in oil circuit breaker design have been made since the type H switch was developed in 1905. As higher voltages and higher rupturing capacities were demanded, the existing breakers were modified to meet the new conditions.

Breakers for 110-kv. service simply were larger models of the existing 60-kv. breakers and the 220-kv. breakers simply enlarged 110-kv. breakers. In this way circuit breakers have come to be one of the limiting features of high tension transmission and require about as much maintenance as all of the remaining equipment combined. They require the most attention at the time of greatest stress, i.e., during line trouble, and their difficulties are liable to be forgotten when the trouble is over.

There also is a tendency on the part of operating companies to allow circuit breakers to remain in service long after they have become inadequate to handle the rupturing duty required.

Types in Use

There are in use on the Pacific Gas and Electric Company system the following types of high-tension breakers:

220 kv.: Westinghouse, 187-kv., 400-amp. breakers, solenoid operated.

110 kv.: both General Electric and Westinghouse, solenoid-operated switches in capacities up to 400 amp., together with a few horizontal four-break switches made by the Pacific Gas and Electric Company, and of a type represented by the Pacific Electric Manufacturing Company switches.

60 kv.: General Electric, Westinghouse, Pacific Electric, six-break; Pacific Electric, four-break; Pacific Gas and Electric Company, four-break.

One way of assisting the development of such equipment is to point out some of the defects developing during operation and such remedies, if any, as have remedied those defects successfully.

220-kv. Breakers

1.—Defects: (a) The small moulded insulators on the quick-break mechanism were inadequate, broke in service and were replaced by bakelite parts which seem thoroughly satisfactory.

(b) There seems to be insufficient reserve power in the solenoid operator so that rather critical adjustment is required between the closing of the dashpot and the opening springs.

(c) It is believed that these switches open much too slow, from 17 to 32 cycles being normal operating time. However, with limitations given in (b) and the weight to be moved the opening distance, no remedy has been developed so far.

2—Advantages: (a) Operating mechanisms are simple.

(b) Life and action of contacts under service is excellent.

(c) Oil stands up well, probably due to (b).

110-kv. Breakers

(1) K-type, General Electric Company, poor workmanship. There have been two cases where K-type breakers could not be assembled without changes. Several breakers have failed to operate due to poor bearings. There seems to be a considerably greater tendency to throw oil in the explosion pot type than normally would be expected. The adjustments are difficult to make and hard to keep.

(2) G-type, Westinghouse, much simpler than the K-type, easier to maintain and on present installations have shown less burning of contacts. In several cases the quick-break mechanism had to be remodeled. The operating mechanism housings have had to be ventilated to prevent mildew and rust. Adjustments easy to make and maintain when solenoid has enough reserve power.

(3 P. G. and E. 110-kv. type switches are four-break with the moving member moving horizontally as in the Pacific Electric Manufacturing Company design. The rotating member is supported on porcelain insulators which have given trouble by breaking.

These switches have to be opened as well as closed by solenoid and have at times caused trouble by not completely opening or by opening and bouncing back part way closed.

60-kv. Breakers

There are in use General Electric, Westinghouse, Pacific Electric six-break, Pacific Electric four-break and Pacific Gas and Electric four-break types.

The troubles noted on the 110-kv. switches also apply to the 60-kv. switches and in addition there are others due to inadequate rupturing capacity.

These four-break breakers are very low in cost as compared with the standard 60-kv. breakers and have many advantages over fuses. Therefore they can be used to advantage in a great number of cases where the cost of the standard breaker could not be justified.

Due to the number installed, almost as many as of all other types combined, more or less intensive investigation of their faults and troubles has been made and a summary is included with this discussion.

Several plans are under way for improving these breakers.

(1) By eliminating porcelain from the rotating member.

(2) By equipping the switch with a quick-break mechanism.

(3) By improving the operating mechanism.

This operating mechanism is designed to be operated

TABLE I.—Analysis of major switch troubles for year 1924

Voltage switch number and location	Type	Mfgr.	Nature of trouble	Remarks
60 kv., Sta. H., S. F.	400-amp., T. P. S. T., O. D.	P. G. and E. Co.	Bushing flashed over when switch opened on short	Bushing replaced, contacts overhauled.
60 kv., Sta. H., S. F.	400-amp., O. D., 4-break	P. G. and E. Co.	Blew up on short	Supporting insulators had come apart inside tanks, allowing element to ground.
15 kv., Sta. F., S. F.	500-amp., H3	G. E. Co.	Broke down and caught fire when paralleling with Sta. A	Switch probably dropped out after being closed
15 kv., Sta. F., S. F.	300-amp., Type B, Style SO, T.P.S.T.	W. E. & M. Co.	Rat shorted leads just above the bushings	Bushings and terminal leads replaced
60 kv., No. 10, San Rafael Sub.	2-break in tank.	P. G. and E. Co.	Arc between terminal bushing cracked ebony-asbestos top	Due to lightning
60 kv., No. 50, North Tower	4-break	P. G. and E. Co.	Switch tripped out after holding for a short interval	Probably due to a coating of paint on the latch
60 kv., No. 2	4-break in tank	P. G. and E. Co.	Arc between phases burned leads and broke bushing	Due to water leaking into switch tub from roof
60 kv. No. 30, Petaluma	4-break, grounded tank	P. G. and E. Co.	Revolving insulator broken in two	Switch tripped on short
60 kv., No. 10	4-break	P. G. and E. Co.	Arc between phases, bushings broken	Due to severe short
60 kv., No. 4, North Tower	4-break in insulated tank	P. G. and E. Co.	No switch trouble, external arc due to falling bus tube	
60 kv., No. 5, North Tower	Air-break, disconnect		Insulators flashed over	Due to spray from water oolling system
60 kv., No. 20, Cordelia	4-break in insulated tank	P. G. and E. Co.	One phase grounded, broke switch rods and asbestos top	Due to short, switch too small
60 kv., No. 16, Cordelia	4-break in insulated tank	P. G. and E. Co.	Switch failed, broke insulators, rods and tank	Due to short, switch too small
60 kv., No. 12, Cordelia	4-break in insulated tank	P. G. and E. Co.	Switch completely wrecked, one switch cell also wrecked by fire	Switch too small
60 kv., No. 8, Cordelia	4-break in insulated tank	P. G. and E. Co.	Switch failed on short, broke foot insulators, control rods and tops	Switch too small
60 kv., No. 10, Cordelia	4-break in insulated tank	P. G. and E. Co.	Switch failed on short, broke top, control rods and insulators	Switch too small
11 kv., No. 80, North Tower	Type F, Form K-12	G. E. Co.	Poor contact in jaws on one leg caused arc	
6.6 kv., No. 2 Gen., Drum P. H.	H 6	G. E. Co.	Switch broke down and caught fire when separating generator, which was out of step	
500 kv., No. 3 Gen., Alta P. H.	1,000 amp.		Switch began to smoke after carrying 1,100 amp. for 12 hours	
4 kv., No. 139303, Sta. I, Oakland	330-amp. Type F., Form K, 7,500 volt	G. E. Co.	Switch blew up on short, can blown off, bushings broken and contacts burned	
11 kv.,Cal.-Hawaiian Sugar Co., Crockett			Bushing broken and leads burned off, shorted by rat	
11 kv., Concord-Pacheco Circuit		P. E. M. Co.	Strain insulator broke down	Due to short on 60-kv. line at Banta
60 kv., No. 70, Manteca	2-break, grd. tank	P. E. M. Co.	Switch blew up and caught fire	
104 kv., No. 102, Manteca	4-break, grd. tank	P. E. M. Co.	Rotating element fell off pin	
4 kv., No. 4 Gen., Stanislaus	H 3	G. E. Co.	Switch blew up, A-phase tank demolished and contacts badly burned	It is assumed that switch did complete opening stroke or pumped back to closed position on A-phase only
60 kv., No. 60, Manteca	2-break, grd. tank	P. E. M. Co.	Bushing punctured and grounded B-phase when switch opened on short	
60 kv., No. 20, Pt. Marion	2-break, grd. tank	P. E. M. Co.	Burning oil was thrown out of all three tanks, switch badly damaged	Switch tripped on severe short grd. switch was closed on line by mistake
6.6 kv., River sub	6.6-kv. oil switch.		Switch handle latch would not hold	
60 kv., No. 2, Inskip P. H.	2-break, grd. tank	Nor. Cal.	Rust prevented operating rod from closing switch properly	
60 kv., No. 4			Casting broke on operating lever, one bushing broke down	
6.6 kv., No. 74, Coleman P. H.			Closing solenoid shorted	
60 kv., No. 20, Cottonwood			Arched supporting casting cracked	
60 kv., No. 2, Kennett	2-break, grd. tank	Nor. Cal.	Center bushing on one phase loose on revolving pin	
60 kv., No. 20, Cottonwood			Control lever casting broken	
60 kv., Inskip-Kelman	Oil Switch		Insulator on bottom of switch holding blades became loose	
Tertiary Sw., Williams			Adjustment slipped	
4 kv., No. 4 Circuit, Hammonton			Short on line caused switch to kick-out and throw a small amount of oil	Switch not damaged
11 kv., No. 900, E. Nicholaus	FKO-37, 400-amp. 1,500-volt	G. E. Co.	Switch started an arc when testing a shorted line	Minor repairs were made to switch

by a ¼-hp. motor of either 125 volts a.c., 125 volts d.c., or 24 volts d.c. It simultaneously winds two springs, one for closing and one for opening. Approximately 7 seconds is required to rewind after tripping.

One of these mechanisms tested on a 60-kv. switch opened and closed the switch over 5,000 times without a failure and without damage to either switch or mechanism. Some of the points in which this mechanism differs from the present switch control are:

(1) The mechanism locks the switch in either the open or closed position by a toggle mechanism which is positive and automatic.

(2) The moving parts of the switch have approximately an harmonic motion in closing by which the final closing effect is slow but very powerful on account of the change in effective lever arms.

(3) The opening action starts very fast and is gradually damped by the action on the closing spring.

(4) The springs both are positively wound by the motor and have sufficient stored energy to operate the switch without help from the motor.

(5) After the switch is closed the tripping spring remains stretched ready to operate the mechanism instantly upon the breaking of toggle. No additional time is required for rewinding or for motor operation.

(6) No combination of tripping operation can damage the mechanism. (Some mechanisms require a certain prescribed schedule of operation or they lock halfway open.)

(7) It can be built in any capacity desired, using a longer winding time and the same motor or a larger motor and the same time.

For several years there has been a growing demand for the use of the same oil for transformers and oil-circuit breakers.

One of the larger manufacturers has expressed willingness to use transformer oil where freezing weather does not occur. (Copley, Westinghouse.) The other large manufacturer still insists upon a specific oil-switch oil.

General

It is believed that oil-circuit breakers today are the limiting equipment on high-tension transmission systems and that the best type at present available have too heavy moving parts and open too slowly. (The 220-kv. breakers open in about 30 cycles.)

During the year 1924 the Pacific Gas and Electric Company had approximately 22 major cases of oil-circuit breaker trouble due to failure or defects in breakers themselves. This does not include minor mechanical difficulties, damage by lightning or by arcs started from causes exterior to the breaker or other cases of trouble for which the breaker itself could not justly be blamed. These 22 cases may be classified as follows, according to circuit voltages:

220 kv.— 0.
110 kv.— 1.
60 kv.—14.
11 kv.— 5.
6.6 kv.— 0.
4 kv.— 2.

A complete list of major troubles involving oil-circuit breakers during the year 1924 is given in Table I.

The Relation of Various Distribution Transformer Primary Voltages *

ATTENTION is directed to the anomalous relation of the primary voltages of distribution transformers for use on 11-kv. circuits, namely 11,500 to 115-230 volts and 6,900 to 115-230 volts for connection in delta and star respectively. The ratio of the primary voltages is 1.67 instead of 1.73. Therefore it is necessary to determine the primary line-voltage to suit the 11-kv. transformer and connect the 6.9-kv. transformer on the 6.6-kv. tap in order to deliver satisfactory secondary voltage to all consumers. This entails a sacrifice of about 4.5 per cent of the transformer winding.

This situation should be rectified by providing a transformer rated at 6,647 to 115-230 volts (a rating of 6,600 volts would introduce an error of only 0.75 per cent, favorable to the consumer).

* System of Pacific Gas and Electric Company.

The same sort of anomaly formerly existed relative to transformers used on 4-kv. circuits and was remedied by the production of a transformer rated 4,000 to 115-230 volts in place of 4,400 to 122-244 volts.

Cooling

At the Columbia Steel substation of the Pacific Gas and Electric Company the water-cooled transformers are supplied with water from the Sacramento River at Pittsburg, Calif. Due to the extreme low water of last year, this water became salty for the first time within our experience and leaks developed around the brazed joints of the copper cooling-coils due to the resulting electrolytic action. The brazed joints were cut out and welded-copper joints made, resulting in a complete solution of the difficulty. This was the first time welded copper joints have been used by the company in transformer cooling-coils.

During the early part of 1925 the second installation of a circulating-oil, transformer-cooling system was made on the system when this means of cooling was applied to four 400-kv. transformers at the Pittsburg substation. This is an old installation and does not involve any features of particular note except that a separate oil pump and external cooling-coil is provided for each transformer. The oil is forced through the cooling coils which are located immediately in the rear of the building where cooling water from the river is caused to flow over them.

By use of this unit-system bad oil in one transformer cannot affect the oil in the remaining transformers.

Frequency Changer Operation

By L. L. DYER and E. R. STAUFFACHER

DURING the period from Jan. 1, 1924, to Dec. 1, 1924, the operation of frequency changer sets as ties between the fifty-cycle system of the Southern California Edison Company and the sixty-cycle systems of the various companies with which power was interchanged was very successful and presents some very interesting information which is shown in Table I.

Location	Capacity	Hours Run	Hours Available but not run	Out of Service Hours
Vestal substation	15,000 kva.	7,819	53	168
Capistrano substation	5,000 kva.	5,044	2866	297
Colton substation	5,000 kva.	1,540	6247	251
L. A. No. 3 substation	5,000-kva.	3,265	905	12

Maintenance Work

Vestal frequency changer was taken off after 108 days continuous run to work on the rotor bars. Off 6 days, 8 hours. After 43 days additional service it was shut down to change the transformer taps. Bearing trouble developed 150 days later necessitating an out-of-service period of 8 hours. The cause of trouble was a loose exciter coupling which allowed the bearing to vibrate. Bearing trouble recurred after 16 more days, causing a 16-hour outage to scrape the bearing.

Capistrano machine end-bells were taken off for the regular semi-annual inspection. Two bars were found broken off. These were replaced and the machine cleaned.

Colton machine end-bells were taken off for the regular semi-annual inspection. Starting bars were brazed to the ring and the machine cleaned.

L. A. No. 3 machine was out of service for 12 hours due to bearing trouble.

Power Interchange in San Joaquin Valley in 1924

By R. D. LIKELY

AS an introduction it may be well to give a brief description of the San Joaquin system in order to make clear the relations of the different points of interconnection to the points of supply and load.

The simplified diagram in Fig. 1 shows only such parts of the system as are concerned with the possible transfer of power to or from other companies. The weight of lines in this sketch shows roughly the relative importance of the different power lines. All lines are 70 kv. except as subsequently noted. The heavy

line through the center of the system is 110 kv., 266,800 circ. mil aluminum. The loop superimposed upon this line is 1/0 copper or equivalent aluminum. Cross connections with the 110-kv. line are 3/0 copper or equivalent aluminum. The change from one voltage to

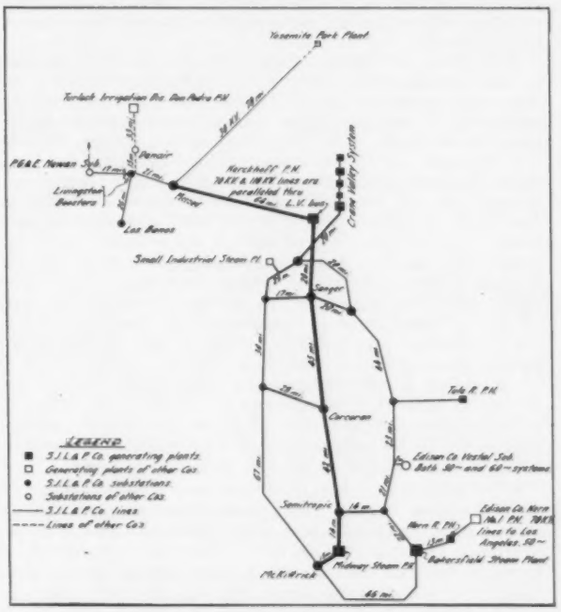


Fig. 1.—Arrangement of principal lines involved in interconnections with San Joaquin Light & Power Corporation in 1924, after construction of Turlock line.

another is made by means of 5,000 kv. auto transformers. Installed transformer capacities at these substations are as follows:

Sanger	30,000 kva.
Corcoran	15,000 kva.
Semitropic	15,000 kva.
McKittrick	15,000 kva.
Merced	15,000 kva.

These transformers also are equipped with tertiary and 11-kv. windings. The latter serve local loads which are fairly heavy at all these points. The other substations shown also are fairly important load centers and switching stations on the transmission system.

The line from Kerckhoff to Merced is of 110-kv. construction with 266,800-circ. mil aluminum, but during the time under discussion was operated at 70 kv. to permit connecting to it certain 70-kv. substations in order to obtain better voltage regulation at these points. This was accomplished by a delta-delta connection of the transformers at Kerckhoff power house. These transformers, which have a nominal high tension rating of 63,500-110,000 volts Y, are operated at slightly over voltage giving approximately 70 kv. delta.

The lines from Livingston to Newman, and from Livingston to Merced are No. 2 copper. From the Turlock Irrigation District's substation to the Livingston substation is 3/0 copper and from the Don Pedro plant to the Irrigation District's substation is 3/0 aluminum.

The principal plants feeding the San Joaquin system are as follows:

Crane Valley system, 5 plants operating principally from stored water and with a peak capacity of 26,000 kw.

Kerchoff, operating principally on stream flow and partly on storage, with a large forebay for fluctuation on daily peaks; peak capacity 38,000 kw.

Tule, operating on stream flow exclusively with no possible fluctuation on the peaks; maximum capacity 5,000 kw.

Kern Canyon, operating on stream flow exclusively with no possible fluctuation on the peaks; maximum capacity 10,000 kw.

Midway Steam Plant, 25,000 kw.

Bakersfield Steam Plant, 25,000 kw.

Description of Interconnections with Other Companies

Points of interconnection with other companies as they existed in 1924 are as follows:

(1) With the Edison company at Vestal—The San Joaquin system which is 60 cycle, is connected at Vestal to the Edison company's Mt. Whitney system which also is 60 cycle. This is shown in Fig. 1. The Edison company's Mt. Whitney system is connected to its main system, which is 50 cycle, through a 15,000-kva. frequency-changer set. The amount of power which may be exchanged depends upon the load on the Mt. Whitney system and upon the output of the small 60-cycle plants on that system. The capacity of the interconnection may be taken as roughly 20,000 kw.

(2) With the Edison company at Kern Canyon power house—The San Joaquin company has a stream-flow hydro plant of 10,000 kw. in one unit on the Kern River, about 12 miles from Bakersfield. The Edison company has a 20,000-kw. stream flow plant in four units a few miles farther up the same river. Power from the Edison company's plant is transmitted to Los Angeles over 70-kv. lines. These two plants are connected by a 70-kv. line and when it is desired, the San Joaquin company's Kern plant may be operated at 50 cycles on the Edison company's system or the Edison company's plant may be operated at 60 cycles on the San Joaquin system. The capacity of this connection depends upon the water available so that the possible exchange varies from a few hundred to 10,000 kw. In emergencies, a 12,500-kw. unit at the Bakersfield steam plant has been operated at 50 cycles. The manufacturer of the unit recommended that the load at 50 cycles not be above 9,000 kw. and estimated that the fuel consumption would be increased about 10 per cent. No trouble was experienced on the few occasions that this was done. This power was delivered over the line from the steam plant to the Kern River plant as shown in Fig. 1, thence to the Edison company. Of course when this is done, the Kern plant also is operated at 50 cycles.

(3) With the Pacific Gas and Electric Company at Newman—Prior to 1924 considerable quantities of power were delivered to the Pacific Gas and Electric Company at Newman over the Kerckhoff-Merced 110-kv. line by operating one unit at Kerckhoff together with the Merced and Livingston substations separately from the remainder of the San Joaquin system. This was necessary due to the comparatively small lines and transformers which do not permit the two systems to be operated in parallel although both are 60 cycles.

There is roughly 75 miles of No. 2 copper, 60-kv. line between the Merced and the Pacific Gas substation at Manteca a point about 35 miles north of Newman, at which the power is delivered to the Sierras-San Francisco 104-kv. system. Due to this fact there was a heavy voltage drop in this line. However, for power delivery to the Pacific Gas and Electric Company, operation without boosters was satisfactory because the normal voltage of the San Joaquin system is actually 70 kv., while that of the Pacific Gas and Electric Company is about 60 kv. The latter company maintained the power factor very nearly at unity.

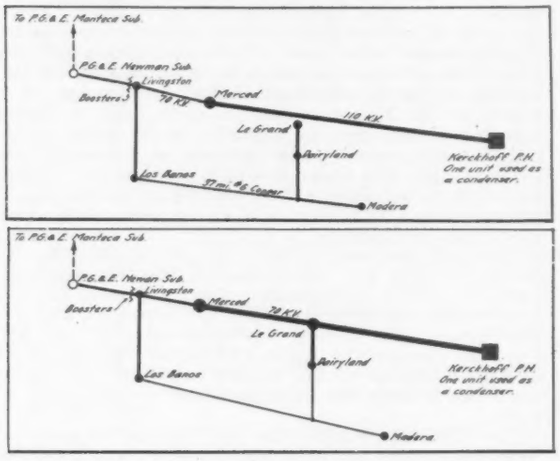
In 1924 it was desired to transmit power only from the Pacific Gas and Electric Company to the San Joaquin company in order that an equivalent amount might be delivered by the latter company to the Southern California Edison Company. The only way in which this could be done was to connect certain San Joaquin substations to the system of the northern company and separate them from the San Joaquin system. This first was done in March when the shortage in the southern part of the state began to be acute.

Owing to the difference in the voltage of the systems and the excessive line drop, boosters were installed at Livingston to raise the voltage approximately 20 per cent. These boosters were standard substation transformers rated 667 kva., 40,000 to 6,680 volts and with high-tension taps down to 36 kv. By using this lowest high-tension tap, connecting the transformers to give cumulative boost and mounting the transformers on insulated platforms the boost of approximately 20 per cent was obtained. Even then it was impossible to obtain high enough voltage unless a leading power factor was maintained.

At first, six substations were connected to the Pacific Gas system as shown in Fig. 2. This transferred a peak load of about 5,000 kw.. It was possible then to operate the Merced-Kerckhoff 110-kv. line at 110 kv., closing it in at Merced and leaving it open at Kerchoff. The addition of the approximately 5,000 kva. charging current of this line was sufficient to maintain the

power factor at Livingston at roughly .85 leading. This brought the voltage about as high as desired. At times of light load it was necessary to drop the Merced-Kerckhoff lines and at other times it was necessary to use a unit of Kerckhoff as a synchronous condenser to reduce the voltage.

As the load on these substations increased due to the growing irrigation load, the voltage again became too low for satisfactory service. At this time the Kerkhoff-Merced line was changed to operate at 70 kv. as explained previously. See Fig. 3. LeGrand, Dairyland and Madera substations temporarily were connected to the Merced-Kerckhoff line. This was possible owing to the fact that LeGrand had been chosen as the location of a proposed future 110-kv. substation and



Figs. 2 and 3.—Above is shown original arrangements of lines concerned with power purchase from Pacific Gas and Electric Company before construction of Turlock line. Below is later arrangement of same lines also before construction of Turlock line.

the transformers and lines at that point were located with this in mind. With this arrangement it was possible to handle slightly more load on the Pacific Gas system by using one unit at Kerckhoff power house as a synchronous condenser to regulate voltage at the receiving end. The maximum load so delivered was approximately 8,000 kw.

Losses incurred during this time were excessive, but were endured because of the urgent need for additional power in the southern part of the state.

After connection was made with the Turlock Irrigation District it was impossible to operate in the manner described. Only two substations, Livingston and Los Banos could be separated from the San Joaquin system and connected with the northern system. By this time the only power which the Pacific Gas and Electric Company had available for sale was that received by that company from the Alameda steam plant through the Great Western system. Fig. 1 shows the arrangement of lines after the Turlock line was built.

(4) With the Turlock Irrigation District at Livingston—During April a long-term contract was signed with the Turlock Irrigation District for the construction of about 15 miles of 70-kv. line from the district's Denair substation to Livingston and for the delivery of power over this line. The Don Pedro plant, which has a capacity of 15,000 kw. at the minimum head and approximately 18,000 kw. at higher heads, is owned jointly by the Turlock and the Modesto Irrigation Districts, the former being entitled to roughly 66 per cent of the plant output. There already was a line from this power house to the Pacific Gas and Electric Company's substation at Modesto by which the latter company received under contract a small part of the output of the plant.

During the construction of the line to Livingston, additional power was delivered to the Pacific Gas and Electric Company over that line.

Also after completion of the line a certain amount of energy was delivered to that company although the San Joaquin company had contracted for all of the Turlock share of the plant above the district's own need. The reason for this was the fact that it was impossible to parallel the two power companies' systems and the output of one unit of the Turlock plant was greater than the combined loads of the Turlock and Modesto systems plus the contract delivery to the Pacific Gas and Electric Company mentioned above. Thus there still was some surplus power which otherwise would have been wasted during the time when it was necessary to release water for irrigation, above the capacity of the plant.

Fig. 4 shows the arrangement of the Turlock lines to get maximum delivery to the San Joaquin company. This amounted to about 11,000 kw. Not all of this would have been available had not a temporary agreement been made with the Modesto Irrigation District for its part of the surplus. The maximum received from Turlock alone was about 8,000 kw. The scheme shown had the disadvantage that in case of trouble on the line supplying the Turlock and Modesto substations it was impossible to switch their load to the line supplying the San Joaquin company owing to the difference in the voltages at which these lines were operated. To make it possible to obtain this additional protection a three-phase auto transformer was installed on the Pacific Gas and Electric Company line at Don Pedro power house so that this line may be operated at 60 kv. while all the other lines are operated at 70 kv. The rating of this auto transformer is 2,500 kva., 73 to 59 kv. with five 2.5 per cent taps on the 70-kv. side so that with 73 kv. impressed on the primary secondary voltage from 59 kv. to 63 kv. may be obtained.

(5) With an Industrial Plant near Fresno—There is an industrial steam plant near Fresno of 3,750 kv. installed capacity of which from 2,000 to 3,000 kw. was available for sale. The inter-connection consisted of three 1,000-kv. 66-kv. to 2.3-kv. transformers and about one-half mile of 70-kv. line as shown in Fig. 1.

(6) With a Lumber Company at Merced Falls—A lumber company has a steam plant of about 500 kw. at its mill near Merced Falls. Its surplus output amounted to about 200 kw. and was delivered over a short 2.3-kv. feeder to the San Joaquin company at its Merced Falls power house.

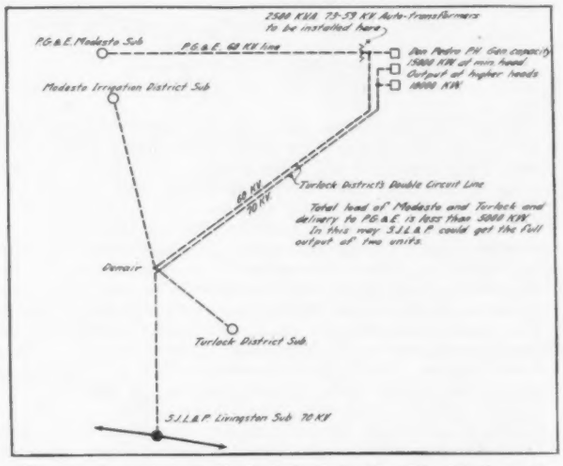

2500 KVA 73-59 KV Auto-transformers to be installed here
P.G.&E. Modesto Sub
P.G.&E. 66 KV line
Don Pedro P.H. Gen. capacity 15000 KW at min. head Output at higher heads 18000 KW
Modesto Irrigation District Sub
66 KV
70 KV
Turlock District's Double Circuit Line
Total load of Modesto and Turlock and delivery to P.G.&E. is less than 30000 KW. In this way S.J.L.&P. could get the full output of two units.
Denair
Turlock District Sub.
S.J.L.&P. Livingston Sub. 70 KV

Fig. 4.—Arrangement of Turlock Irrigation District lines for power delivery from Turlock to San Joaquin Light & Power Corporation in 1924.

(7) With the Yosemite Valley power house of the Department of the Interior—The Department of the Interior operates a 2,000-kw. steam-flow hydro plant on the Merced River about six miles from El Portal. The San Joaquin company extended its 30-kv. line from its Incline sub near El Portal about ten miles up the Merced River to the park plant. The total length of the 30-kv. line from the Merced substation to this plant is about 78 miles. The agreement with the Department of the Interior provides for the sale of the surplus output of the plant to the power company and also for the purchase of energy by the park at times of low water.

General Remarks

Comparatively little trouble has been due to these interconnections. At the substations connected to the Pacific Gas and Electric Company's system there was some trouble from poor voltage regulation due to the long lines of both companies over which the purchased

power was received, but due to the emergency this was overlooked.

With the Turlock plant there was no difficulty so far as the San Joaquin was concerned. They simply carried block loads as required by San Joaquin dispatchers except as the district's demands for water for irrigation modified the operation of the plant. The irrigation requirements took precedence over the generation of the plant, but very little conflict resulted from this cause and practically all of the possible output of the Turlock plant was absorbed. The cooperation of the irrigation district's officials and operating men was excellent and thoroughly appreciated by the San Joaquin company.

TABLE I.—Energy in kw-hr. transmitted through various interconnections with the San Joaquin Light & Power Corporation—1924.

Month	S.J.L.& P. to So. Cal. Ed. at Vestal	S.J.L.& P. to So. Cal. Ed. at Kern	P.G.and E. to S.J.L.& P. at Newman including Alameda Steam	Turlock to S.J.L.& P. at Livingston	Turlock to P.G. and E. on S.J. L.& P. contract	Industrial steam to S.J.L.& P.
Jan.	11,259,000	179,000	0	0	0	0
Feb.	9,245,800	1,551,000	804,000	0	0	0
March	8,811,000	2,772,000	2,641,000	0	0	0
April	6,880,000	978,000	363,000	1,171,000	572,000	0
May	0	0	0	1,939,000	2,210,000	0
June	2,227,000	0	0	6,259,000	475,000	0
July	1,388,000	0	0	8,335,000	718,000	1,007,000
August	8,755,000	0	297,000	7,622,000	476,000	1,661,000
Sept.	7,643,000	0	430,000	2,555,000	0	1,761,000
Oct.	7,330,000	0	445,000	1,738,000	0	1,306,000
10 months total	63,538,000	5,480,000	4,980,000	29,619,000	4,451,000	5,735,000

When delivering power to the Edison company the two systems usually are in parallel and the San Joaquin system is operated with block loads which are changed from time to time at the request of the Edison company's operator at Vestal. Occasionally when the frenquency-changer set was out of service, the San Joaquin company carried most of the load on the Mt. Whitney system and governed its own and the Mt. Whitney systems. During the months of heaviest load it was necessary to be careful that the San Joaquin system did not receive an undue amount of reactive kva. from the Mt. Whitney system. On a few occasions during this period sufficient reactive kva. was received by the San Joaquin system to reduce the voltage of the entire system so much that satisfactory service could not be maintained. Upon taking up the matter with the Edison company's operator at Vestal the necessary adjustments were made on the frequency-changer set and other synchronous machinery on the Mt. Whitney system to restore the voltage of the San Joaquin system to normal.

In this connection it may be noted that while frequency-changer sets for the interconnection of two systems are expensive in themselves and also cause considerable power loss, they may not be necessarily an entire waste as they may be useful to take the place of synchronous condensers on one or both of the systems so connected.

Table I shows the amount of power transferred between the various companies.

In general, relations between the various parties to these interconnection agreements have been very harmonious and practically everything possible was done to deliver the maximum amount of energy to the southern part of the state.

Distribution Transformer Ratios

By H. H. MINOR

THE company has experienced some difficulty in the use of 11-kv. and 6.9-kv. distribution transformers. It is the company practice to use 11.5 kv. to 115-230-volt transformers for isolated single-phase loads and 11.50-kv. transformers for large three-phase installations. The standard voltage ratings are respectively 11.5 kv. to 115-230, 11.5-kv. to 230-460-575 and 11 kv. to 2,300-4,000 Y for transformers to handle this class of business.

For smaller three-phase installations and for small combined three-phase and single-phase installations 6.9-kv. class transformers connected Y-delta are used. Their standard ratio is 6,900-11,950 Y to 115-230 volts.

Thus it is possible to have the following condition on four plants served from the same 11-kv. line, assuming the primary voltage to be 11.5 kv. in each case and all transformers connected on full primary winding and disregarding transformer regulation:

(1) A single-phase load served by an 11.5-kv. transformer; secondary voltage 230.

(2) A large power consumer served by 11.5 kv. to 230-volt transformers; secondary voltage 230.

(3) A large power consumer served by 11-kv. to 23-kv. transformer; secondary voltage 2,404.

(4) A small power consumer served by 6.9-kv. transformers; secondary voltage 221.5.

Cases 1, 2, and 4 are very common with the company who are confronted with using the 5 per cent tap on 6.9-kv. transformers universally in order to equalize their secondary voltages with those of the 11.5-kv. transformers. This makes the full winding connection of the 6.9-kv. class unnecessary. The above condition is one which feeder regulators will not correct.

The question is taken care of partially in the Electric Power Club Standards by the adoption of 6.3-kv., 6.0-kv. and 5.7-kv. taps for 6.6-kv. transformers with secondary voltage below 600. However, there are many transformers without this 5.7-kv. tap.

Case 3 is met with to disadvantage when lighting load is served from large power banks through 2.3-kv. transformers, particularly during periods when the power service is not being used and transformer regulation does not help out. This same condition also occurs in small 11-kv. to 2-kv. substations. Feeder regulation will help in this latter case, but results in the regulators always working on the "buck" and they must have a greater range than would be necessary were the ratio of the large power transformers more nearly like the distribution transformers.

It is the tendency to operate so-called 11-kv. lines at about 12 kv. at the substation bus, or even higher in some instances. This agrees perfectly with the 6,900-11,950 Y rating of the 6.6-kv. class transformers. It would seem then, to be the logical step to make the 11-kv. class agree by adding a 5 per cent higher tap, i.e., making them 12,075-11,500-10,925-10,350 to 114-230, etc. Thus the two classes of transformers would be in agreement throughout and the 11-kv. class, or 12-kv. class, as it would have been, would be rated at more nearly the voltage at which it is used and insulations, losses and other items would be figured for that voltage.

For power transformers supplying 600 volts and below it would be well to make them as follows:

12,075-11,790-11,500-11,215-10,925 to 230-115, etc., thus maintaining the present standard of four 2½ per cent taps. For power transformers supplying secondary voltage greater than 600 volts a desirable change would be to make the ratio as follows:

11,825-11,550-11,275-11,000-10,725 to 2,300-4,000 Y. In both of the above cases taps would be available so that transformers manufactured under these specifications could be banked with or paralleled with the present standard transformers.

Considering the same four cases as above with transformers of the ratio suggested the following secondary voltages would result, the primary voltage being maintained at 11.5 kv. in each case.

(1) A single-phase load served by a 12,075 to 230-volt transformer; secondary voltage 219.

(2) A large power consumer served by 12,075 to 230-volt transformers; secondary voltage 219.

(3) A large power consumer served by a 11,825 to 2,300-4,000 Y bank; secondary voltage 2,237.

(4) A small power consumer served by 6,900 to 230-volt transformer; secondary voltage 221.5.

Pacific Gas and Electric Company Power Interchange

By H. T. SUTCLIFFE and B. D. DEXTER

THE various points of interchange between the Pacific Gas and Electric Company and other utilities as of March 1, 1925, are shown in Table I, together with the voltage and capacity of connections and generally pertinent data. The numbers in parentheses in the second column refer to corresponding numbers on the high-tension system map shown in Fig. 1. The letters in column three indicate the limiting factor in de-

livery at the various interchange points and show whether the limitations are based upon generator, transformer or line capacity.

Although at a few of our interchange points step-up or step-down banks are provided to compensate for slight differences in line voltages of the connecting companies, these voltage adjustments are fixed. There is but one connection where regulation is provided and this is the connection made with the system of the Truckee River Power Company. A brief description of this interconnection is of interest.

The main generating capacity of the Truckee River Power Company comprises five hydro plants, four of which step up to an interconnecting network of 23 kv. This voltage is stepped up at their Washoe plant through a delta-delta bank to 63 kv. and their Verdi plant output is stepped up to 63 kv. to tie into this high-tension bus. The interconnecting line from Spaulding No. 1 power house of the Pacific Gas and Electric Company ties into this 63-kv. bus through the regulating equipment to be described. The system of the latter company is grounded Y and the Truckee River system is connected delta at this point. The metering point for this interchange is located at the summit of the Sierra Nevada Mountains approximately 18 miles from Spaulding and 49 miles from Washoe.

TABLE I.—Interchange points on system of Pacific Gas and Electric Company

Connecting utility	Point of connection†		Capacity in kw.*	Voltage in kv.
Calif.-Oregon Pwr. Co.	(1)	Delta	12,000 L	60
City & County of San Francisco	(2)	Priests	3,000 G	17
Coast Counties Gas & Elec. Co.	(3)	Davenport	2,250 T	22
	(4)	Morgan Hill	3,000 T	22
	(5)	San Juan	3,000 T	22 & 4
Coast Valleys Gas & Elec. Co.	(6)	Salinas	5,000 T	60
	(7)	Alisal	5,000 T	60
Great Western Pwr. Co.	(8)	Oakland	5,000 T	11
	(9)	Oakland	15,000 T	60
	(10)	San Francisco	7,000 L	11
Melones Mining Co.	(11)	Jeffersonville	1,000 G	17
Modesto—Turlock Irrig. Districts.	(12)	Don Pedro	4,000 T	60
San Joaquin Lt. & Pwr. Corp.	(13)	Newman	12,000 L	60
Snow Mountain Water & Pwr. Co.	(14)	Santa Rosa	5,000 G	60
Truckee River Pwr. Co.	(15)	Summit	8,000 L	‡60
Western States Gas & Elec. Co.	(16)	Stockton	15,000 T	60
	(17)	Manteca	2,250 T	30
	(18)	Junction City	2,000 L	60

*Letters signify the limiting factor in delivery, either generator, transformer or lines.
†Figures refer to Fig. 1.
‡Regulated.

The voltage on the system at Spaulding is approximately 60 kv. and allowing for a voltage drop of 52 kv. at 5,000 kva. it is necessary for the regulating equipment at Washoe to boost upon delivery from the Pacific Gas & Electric Company system to the Truckee River system from a low voltage of 54.8 to 63-kv. This same equipment will boost upon delivery in the reverse direction from 63 kv. on their bus to a maximum of 67 kv.

When the regulating equipment first was contemplated, consideration was given to straight automatic induction voltage regulation similar to the type commonly used for feeder regulation. The cost of this equipment was found to be so excessive that the installation finally was made with shunt and series transformers taking the place respectively of the primary and secondary of an induction regulator. The winding of the three-phase series transformer which is connected in the line has a normal operating capacity of 79 amperes which at 63 kv. between wires provides for an interchange of approximately 8,500 kw.

The series boosting or bucking transformer is excited by means of three single phase shunt transformers the secondaries of which are provided with taps so that step-by-step regulation may be obtained. Five steps are used each providing a buck or boost in the main line of approximately 1,640 volts. All five of these taps may be used for delivery to Truckee River but on reverse delivery not more than three normally are used.

Taps in the low-voltage side of the shunt transformers are changed by means of contactors operated by cams mounted on a shaft which is connected to a motor. The motor is energized through the operation of a contact-making voltmeter in a manner similar to the operation of an ordinary induction voltage regulator. Limiting resistors are provided between these contactors to absorb the energy from the section of the transformer winding between two adjacent taps shorted during the interval of cutover. The contact-making voltmeter responds only to variations in line voltage of approximately 1,000 volts between wires. A line drop compensator is included in the circuit for power delivery from Truckee River to Pacific Gas and Electric Company in order to compensate for voltage drop in the 67 miles of line, but is not included in the circuit for delivery to Truckee River.

The position of the contactors is indicated by means of a lamp indicator system so that the operator at all times can tell upon which tap the regulator is operating.

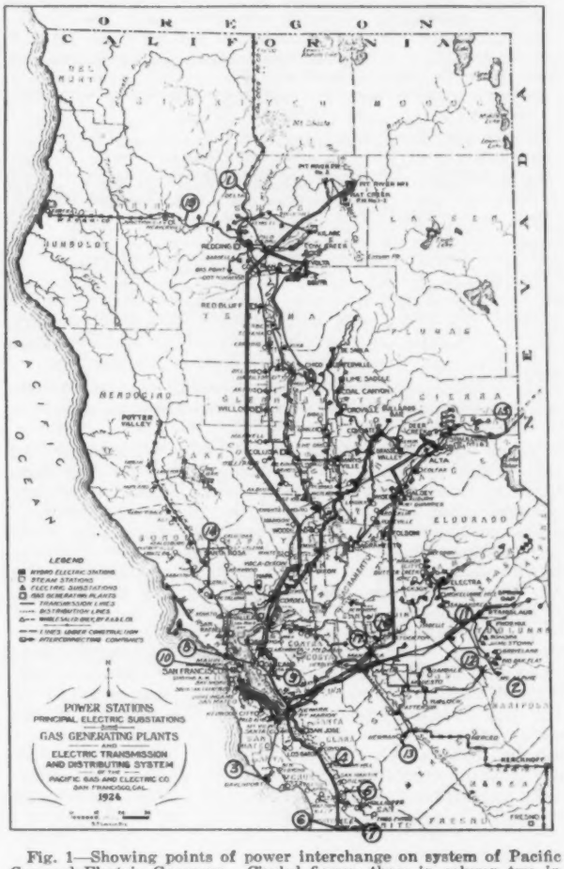


Fig. 1—Showing points of power interchange on system of Pacific Gas and Electric Company. Circled figures those in column two in Table I.

The cams operating the contactors are arranged to positively open the latter in case one of them should freeze shut. In other words cams are normally opened by springs in the usual manner, but in case excessive current should cause one of them to freeze, the cam will follow up the spring's action and force the contactor open.

Under short-circuit conditions where an excessively high current is drawn through the series transformer windings connected in the main line, voltage relays on the other windings of this transformer operate to short circuit through a resistor what is then the secondary. This resistor also shorts the secondaries of the shunt transformers. The series transformer is so designed thath the iron reaches its saturation point at a voltage of 2.5 times its normal voltage. This prevents the building up of excessive voltages and consequent damage to the equipment in the case of short circuits on the main line.

Relays and Relay Application

By R. C. DENNY

IN the matter of protective relays there have been in the past year no applications of an entirely new nature on the system of the San Joaquin Light & Power Corporation. The transmission line switches, howover, practically all have now been equipped with the modern induction-type relay. Where the switches

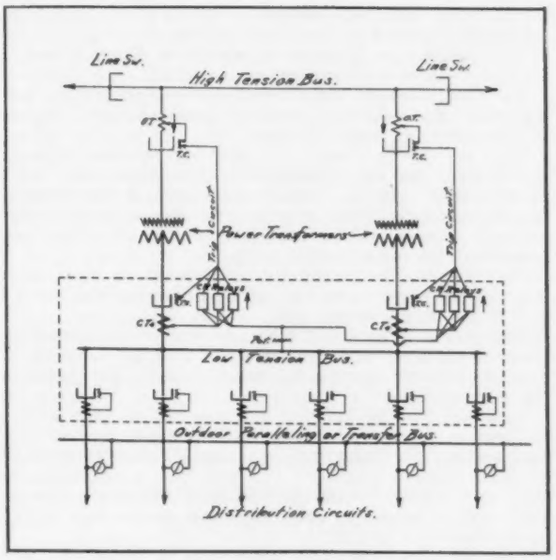


Fig. 1.—Showing scheme of transformer protection for 2-bank substations.

may be part of a loop and a two-way feed involved, the directional induction-type overload relay is used while in the case of stub lines the straight induction-type overload relay is used. In general the operation of these relays has resulted in greatly improved system operation and more nearly continuous service. Experience has demonstrated, however, that the proper selective action of such relays to a large extent is dependent upon the proper functioning of the switches themselves. Very often switches that are inherently sluggish will upset the best-laid plan of relay operation. Occasionally defects of a minor nature in the auxiliary circuits will prevent otherwise proper operations. It would seem therefore that successful relay operation is tied in quite definitely with switch maintenance of a very high order.

There has been an installation of low-energy overload relays for the differential protection of four 4,000-kw. generators in one of the older, but still important hydro plants. A scheme of protection, shown in Fig. 1, uses one bank against another and has been applied in substations where there are two or more banks of transformers. This is equivalent to differential protection yet requires neither high-voltage nor bushing-type current transformers. This scheme is accomplished simply by connecting on the low-tension leads a group of directional relays set to close contacts when power flows back into the transformer bank and which in operating open both the high- and low-tension transformer switches, thereby dropping the bank. Ordinary series overload protection may be applied on the high side in such cases.

Short Circuit Duty on Kelman Switches at Laguna Bell Station

By E. R. STAUFFACHER

A HEAVY short circuit duty was imposed upon one of the Kelman 60-kv., type-3 D6 switches located at Laguna Bell substation on Feb. 10, 1925, at 11:12 p.m. A 60-kv. short circuit occurred on the Santa Fe Springs circuit about six miles out of Laguna Bell substation. The 60-kv. switches at Laguna Bell and Santa Fe Springs substations cleared the short circuit and calculations indicate that the duty imposed upon the switch at Laguna Bell substation was as follows:

	Kva. Interrupted	Amp. at 63 Kv.
Actual duty, 0.7 Sec. elapsed between the time the short circuit started and the time the switch opened	394,000	3,600
Relay set at 0.4 Sec.		
Instantaneous duty possible under these conditions	550,000	5,060

The station crew reported that only a slight amount of oil was thrown from the switch. From the above table it would appear that 500,000 kva. would be a conservative rating for this particular type of switch.

New Types of Protective Relays

By H. T. SUTCLIFFE, R. W. WILKINS and H. S. LANE

THE report is submitted categorically in accordance with the outline furnished by the chairman of the apparatus bureau. Under the headings (a) New Types of Relays for Protection of Transmission Network, and (b) New Types of Relays for the Protection of Internal Trouble in Equipment, extracts are submitted from a report covering an investigation by the bureau of tests of the Pacific Gas and Electric Company of two relays manufactured by the Swedish General Electric Company, Ltd., namely:

Type RI inverse time-element over-current relay.

Type RIK definite minimum time-element over-current relay.

Construction and Operation

These relays are for use with alternating current of 60-cycle frequency. Both relays operate on the induction principle. An aluminum disc is caused to rotate continuously by the interaction between a flux from the electromagnet and an out-of-phase set up by a shading coil on the pole piece of the electromagnet. A permanent magnet acts as a damper. This disc ceases to rotate only when the current falls to less than approximately ten per cent of the normal current setting. The shaft of the rotating disc is pivoted vertically between the arms of a fork-shaped bracket. This bracket itself is pivoted on a vertical axis and is free to swing on that axis through a small angle. The weight of the disc is counterbalanced.

The lower disc-bearing consists of the rounded end of the disc shaft bearing upon a small steel ball which in turn is seated in a jewel. This ball is the same size as that used in Westinghouse meters, 63 mils in diameter. The upper bearing is a simple guide bearing.

With normal current conditions the disc rotates freely, but upon a sufficient increase of current the force rotating the disc also swings the fork-shaped bracket forward against the tension of a light spring. On the shaft of the disc is cut a worm gear which being thus carried forward is meshed into a toothed sector. Continuance of rotation of the disc rotates the sector to which is fastened an arm which in turn trips a normally magnetically-balanced armature, also excited by and a part of the main electromagnet. Tripping of this armature forces together, or can be made to open up, the relay trip contacts.

The type RI has current settings for 4, 5, 6, 7, 8, 9 and 10 amperes and time settings variable from 3 to 16 seconds. The type RIK has current setting for 4, 5, 6, 7, 8, 9 and 10 amperes and time settings variable from 2 to 10 seconds.

For the type RI meter the time settings are the tripping times for 100 per cent current setting, whereas in the case of the type RIK meter the time settings are meant to be the definite-minimum-tripping times for from 400 per cent to 1,000 per cent current setting. The time is varied by changing the initial position of the toothed sector, thus changing its length of travel before it trips the armature.

The shading pole of the type RI is larger than that of the type RIK, the result being that its characteristic curves are not so flat as those for the type RIK which is meant to be a constant-time-limit relay at above four times normal current.

Once the current has risen sufficiently to mesh the toothed sector with the worm on the dial shaft, the tripping operation will be completed unless the current falls to approximately 80 per cent of the set value before this completion, in which case the mechanism resumes its normal position. This entirely prevents "floating."

The disc rotates slowly upon passage of a current of approximately 10 per cent of the current setting. This gives the operator a partial indication that the relay is in working order.

Other Features

The relays may be adjusted to operate instantaneously at 4, 6 or 8 times the ampere setting by turning a knurled nut to these inscribed marks. Other values could be found by calibration.

This knurled nut alters the condition of magnetic balance of the centrally pivoted armature by opening up one air gap and correspondingly closing the other. When the relay functions, one air gap is reduced to a close contact. By initially shortening this air gap the necessary amount, a given overcurrent will operate the trip without first meshing the disc-shaft worm with the toothed sector.

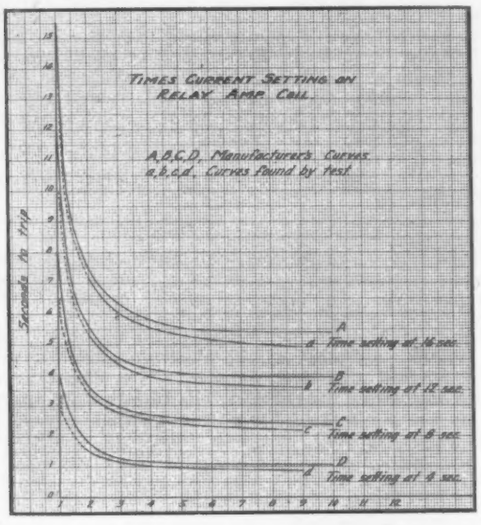


Fig. 1—Characteristic curves of type RI, time-element, overload relay manufactured by Swedish General Electric Company, Ltd.

The contacts easily are changed from circuit opening to circuit closing or vice versa.

The changes in current settings can be made while the relay is in service. All the current taps are brought out in a line to rectangular studs. A heavy hinged corrugated plate covers these studs in such a manner that by inserting a metal plug into a concavity between the plate and any desired stud, the circuit is completed for that particular current tap. Changing the current setting does not open the current circuit, for before the plug is totally withdrawn the hinged plate closes the circuit of the 10-amp. tap.

All connections are made from the back of the relay. Extra studs are supplied to suit thickness of the switchboard.

The weight of each relay is 6.7 lb. Its horizontal length is 9.2 in., its height 5.4 in., and its depth 5 in. The back of the relay is of cast alloy and the cover of brass. A hinged lid has a glass inset 4.2 in. by 3.4 in. in size, sufficiently large to show the name plate on which are drawn the characteristic curves of the relay and the figures representing the relay settings. The name plate of the type RI relay is black with white inscriptions, while that of the type RIK is white with black inscriptions.

Provision is made for sealing the lid closed. Nevertheless the whole cover can be taken off by the removal of four screws.

Tests Made

1. Characteristic curves of relays and repeating accuracy.
2. Speed of disc, free and driving sector.
3. Proportionality of time settings.
4. Resetting value of current as percentage of "pick-up" value.
5. Current required for rotation of disc.
6. Accuracy of calibrations for instantaneous trip.
7. Volt-ampere and watt loss.

Results

Test No. 1—These curves were obtained on the 4-amp. tap at different time settings with the instantaneous trip set at 40 amp. The tripping times were determined by use of a cycle counter.

The type RI relay required 4.2 amp. to mesh the sector, the type RIK required 4.54 amp.

The results are plotted as shown in Figs. 1 and 2, together with the manufacturer's curves.

Test No. 2—Type RI relay: Current on 4 amp. tap, 4.2 amp. Speed of disc, running free, 97 r.p.m. Speed of disc, driving sector, 87 r.p.m.

Test No. 3—Test made by passing 16 amp. through the 4-amp. coil and noting tripping time with each time setting. At the higher time settings the proportional time on both relays was quite accurate. At lower settings it was somewhat high on the RI relay and somewhat low on the RIK relay.

Test No. 4—The reset-value of current on the 4-amp. tap was 82 per cent of the pick-up current for the RI and 79 per cent for the RIK.

Test No. 5—The slowest speeds with which the discs rotate with certainty were effected with 16 per cent of pick-up current on the RI relay and 10 per cent on the RIK.

Test No. 6—The knurled nut was set at each of the calibration points indicating the multiplier of the current setting for instantaneous trip. Tests were made on each current setting. The points are approximate only and change with the different current settings. The ratio of actual to calibrated trip on the two relays varied from .79 to 1.47.

Test No. 7—Type RIK, amp. tap, 5; amp., 5; volt drop, 5.65; volt amp., 28.2; watts, 9.9; P. F., 0.35: Type RI, amp. tap, 5; amp., 5; volt drop, 1.41; volt amp., 7.05; watts, 3.7; P. F., 0.53.

Conclusions

These relays have many good features and though not calibrated very accurately their repeating accuracy is good. In particular should the instantaneous trips be re-calibrated.

As in the Westinghouse CO and the General Electric IA, no adjustment is provided which will change the shape of the characteristic curves.

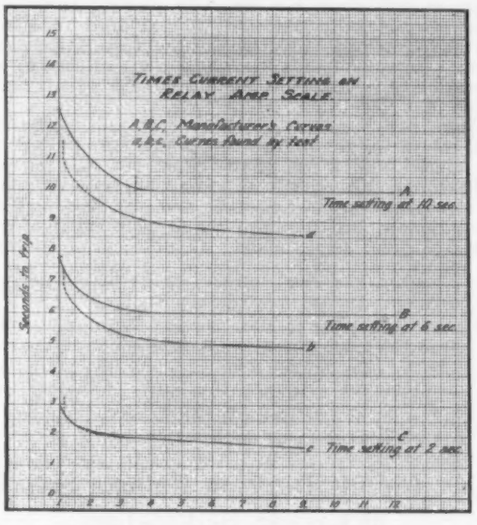


Fig. 2—Characteristic curves of type RIK, time-element, overload relay manufactured by Swedish General Electric Company, Ltd.

The curve sheets reproduced in the accompanying illustrations show that the characteristic curves of the two types at above 200 per cent current setting are very similar, hardly sufficient to justify the distinction between the type RI as an inverse-time overload relay and the type RIK as a definite-minimum overload relay The fact that the curves approach the horizontal at much less percentage overcurrent than do the curves for the Westinghouse standard type CO relay or the General Electric type IA-201 relay makes this relay valuable where such a characteristic is desirable.

The bearings are good. Yet without slight lubrication of the bottom bearing the disc chatters. A valuable feature is the continuous rotation of the disc even at 10 per cent of normal current settings. This gives a visible indication of its being prepared to function. "Floating" at the trip contacts cannot occur. Once the

tripping operation has commenced it must continue to completion or the mechanism reset to normal. The trip contacts can be made circuit opening or circuit closing. In either case the action is fast and definite. The current transformer secondary can not be opened accidentally while changing the current tap settings. Energy loss is 28.2 volt-amperes for type RIK and 7.0 volt-amperes for type RI.

For a comparison, the Westinghouse standard CO of the 4-12 amp. range has a loss of approximately 18 volt-amperes on the 5-amp. range and the low energy relay a loss of 7.4 volt-amperes. The General Electric type IA-201 has a loss of 7.6 volt-amperes on the 5-amp. range and the type IA-101 a loss of 7.1 volt-amperes.

The relay covers are not all that could be desired. They are cheaply made. The point of a pencil can scratch off the black enamel. To change relay settings the lid is opened on its hinge. The whole cover is easily removed to expose the relay mechanism. The lid can be sealed. The relay mechanism itself is well made.

Relay Protection as Applied to a Large Transmission Network

By R. W. WILKINS

THE practices of the Pacific Gas and Electric Company have been developed as the result of a number of years experience in the operation of this large system, and are designed to separate completely the smallest practicable section in such manner as to cause the least possible disturbance. The company's high-tension system comprises 28 hydroelectric plants, four steam plants, 412 miles of 220-kv. line (one-half of this now operating temporarily at 110 kv., 5.15 miles of 110-kv. line, 290 miles of 104-kv. line, 1,889 miles of 60-kv. line, and 160 miles of line at from 20 to 30 kv. The arrangement of this system is indicated on the accompanying map.

The standard generator connection is a grounded "Y" without resistance in the ground connection. Certain of the older generators are connected delta. In one case different characteristics of generators on the same bus made necessary the introduction of ground resistance.

Power-house transformers are connected delta-Y, with the high-tension neutral solidly grounded. Most of the receiving transformers are connected Y-delta with the high-tension neutral solidly grounded. There is on the system, however, an increasing number of auto-transformers Y-connected with the neutral solidly grounded at the substation ends of transmission lines, particularly at the higher voltages. In order to conform to the state ruling on inductive interference these have a third or tertiary winding connected in delta.

*This article appeared in the Nov. 22, 1924, issue of Electrical World.

Advantages of Relay System

There are several advantages to the system of relay protection which has been developed by the Pacific Gas and Electric Company.

(1) Single-phase grounds are removed very quickly with a high degree of selectivity.
(2) The system is applicable to single lengths in the transmission network as well as to one circuit of a pair of circuits or one circuit of three or four parallel circuits.
(3) Experience shows correct operation even where a ground may be within five per cent of the length of the line from the far end.
(4) No change in relays or character of protection is required when one circuit of a twin line is switched out.
(5) It may be used with bushing-type current transformers.

From actual trials of virtually all proposed methods the system seems best taken care of by the following relays:

(1) Overload induction type—Used on single radial feeders, so-called "stub-lines" (either with or without a residual), on auto-transformers and on smaller tie lines such as 11-kv. lines tying together parts of the system.
(2) Differential or balanced type—On generators, synchronous condensers and two-winding transformers having a rating sufficiently large to warrant it.
(3) Reverse-power and residual combinations—For receiving ends of transmission lines.
(4) Reverse-power and directional residual combinations—for the sending end of transmission lines.
(5) Directional residual relays—On ungrounded or delta-connected generators and feeders.
(6) Special connections—To meet abnormal load or power-factor conditions or badly fluctuating loads.

Inasmuch as a considerable portion of the relays are actuated from bushing-type current transformers operating at comparatively low currents, they are calibrated over-all in place. The settings are on the inverse part of the time-current curve and always above the minimum current at which the relay closes. Relays in general are made selective as to direction and amount of current and in case of necessity to time, although the directional features seem to be more reliable. Certain directional combinations involving only current have proved in service to be superior to those in which voltage and consequently power factor is involved, particularly where low settings are desired.

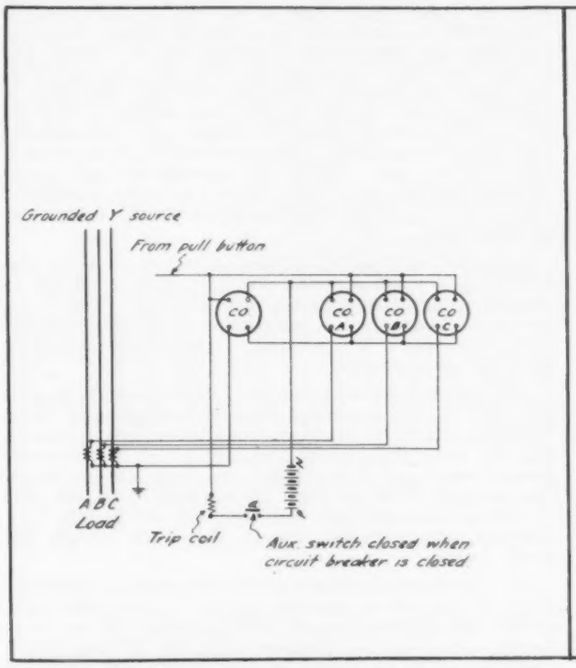


Fig. 1—Diagram of connections for three CO relays and one residual-current CO relay.

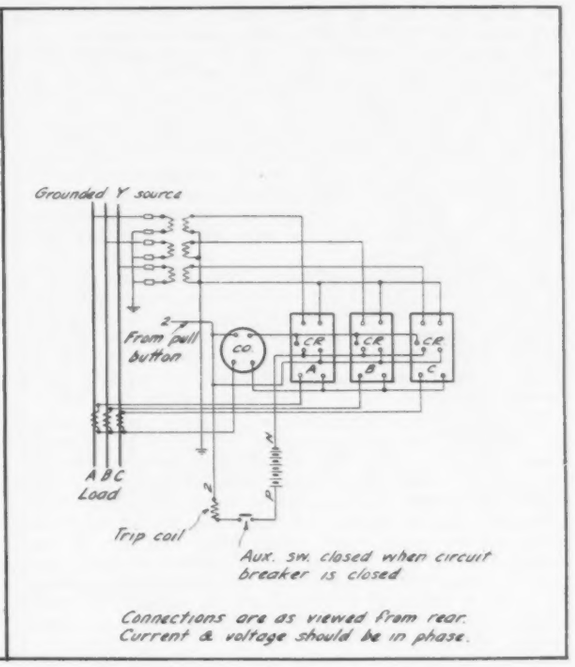


Fig. 2—Diagram of connections for three 7-stud CR relay and one residual-current CO relay.

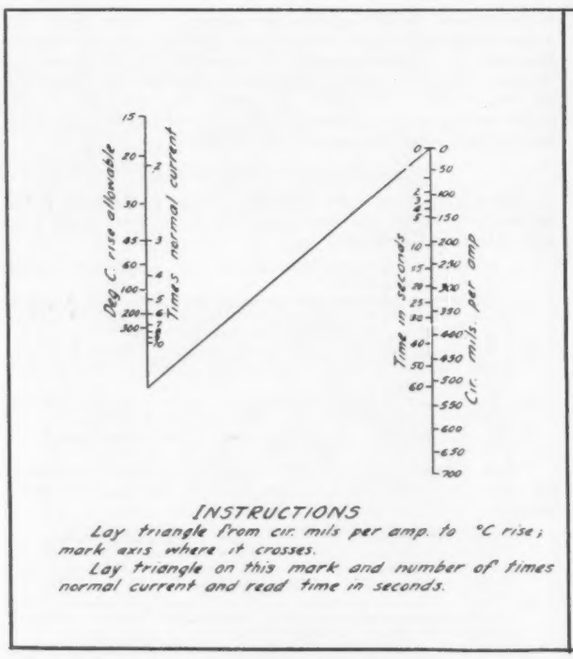

Deg. C rise allowable
Times normal current
Time in seconds
Cir. mils. per amp
INSTRUCTIONS
Lay triangle from cir. mils per amp. to °C rise; mark axis where it crosses.
Lay triangle on this mark and number of times normal current and read time in seconds.

Fig. 3—Chart for calculating heating of electrical equipment under short circuit and with no radiation.

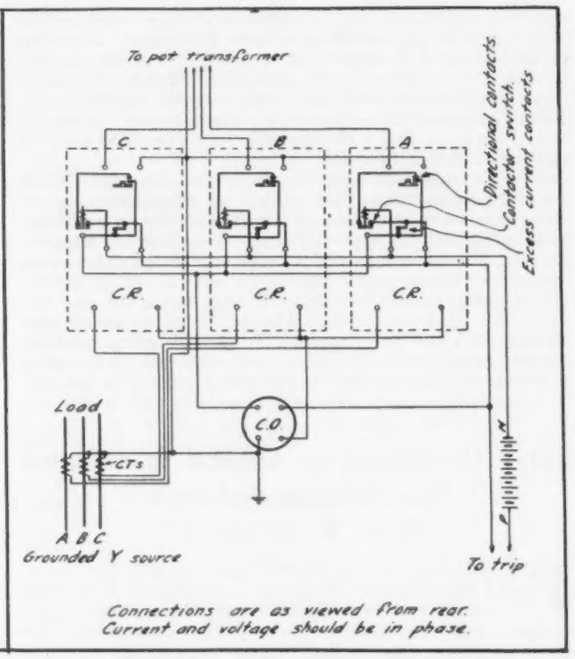


Fig. 4—Diagram of connections showing internal trip-circuit for three 7-stud CR relays and one residual-current CO relay.

Functions of Various Types

(1) In referring to overload relays it is to be noted that induction-type relays are specified. It is thought that any high-tension relay installation is of sufficient importance to justify the additional expense over the older types. High-tension current-transformer secondaries are connected Y and the simple overload connection is that usually used.

The overload induction type in use at this time is of two general types, one operating on the same principle as the ordinary induction-type watthour meter and one using a shading coil. Both types are in use on the system.

When it is desirable to separate on low values of unbalanced current or on grounds, the residual relay is connected as shown in Figs. 1 and 2. By using a relay of a lower current rating very low values of grounds and unbalance may be taken care of, in most cases as low as 20 per cent of the normal load current.

On auto-transformers at the higher voltages overload relays on all windings have been preferred. First, because the various combinations of loading possible make some sort of maximum current rating for each winding imperative, and second, because it is very difficult to balance properly a three-winding or four-winding transformer using bushing-type current transformers on the high-tension side and some other type on the low-tension side. Transformers are set within a maximum heating limit (see Fig. 3) with about 200 per cent normal current.

(2) Differential or balanced type relays are used on all Y-connected generators and synchronous condensers, and all new equipment is specified to be Y-connected. Here the current transformers are duplicates having similar characteristics, and instantaneous plunger-type overload relays commonly are used, set to trip on a current unbalance of about 20 per cent of full load.

The power-house transformers usually are protected by differential relays in order to withstand heavy overloads without clearing and yet clear on internal trouble. Trouble has been encountered in balancing where current-transformer characteristics were different. This sometimes can be helped by balancing in the magnetic circuit of the relay itself, using from, say, zero to the 4-amp. tap for one current transformer and from zero to the 6-amp. tap for the other, connected in opposition. On delta-Y banks it is customary to connect the low-tension current transformers inside the delta to insure correct phase relations.

In this connection it is of interest to note an installation of balanced relays for the protection of a bank of transformers comprising a main 60 to 100-kv. auto-transformer star winding with 11-kv. star winding. The current transformer and relay connections are shown schematically in Fig. 12. Theoretically no current would flow in the relay for all conditions of loading of both high-tension and 11-kv. windings, except for trouble within the high-tension winding. Actually the ratios of the bushing-type current-transformers varied between (14/1) and (23/1) as the load increased, while the ration of the core-type coils remained practically constant.

A consideration of the factors involved clearly indicates that it is not feasible to balance the ratios of the several current-transformers by adjusting their respective secondary loads. The ratio characteristic of the bushing-transformers is distinctly drooping, that of the core-type substantially flat. Changing the secondary load on either type raises or lowers the characteristic curve without materially changing its form. Consider also that the power factors of the 100-kv., 60-kv. and 11-kv. loads may be materially different, and so affect the phase relation of the several currents and that in this case power may be supplied from either the 100 kv. or the 60 kv., the presence or absence of a considerable 11-kv. load influencing the relative effect of the neutral CT's in either case. While it is conceivable that a substantial balance might be obtained at some particular combination of loads, this condition would not persist at other loads.

Nevertheless a setting is obtained which provides protection to the high-tension winding against failure at somewhat less than full-load rated current of the transformer. Obviously no protection is afforded against failure of the 11-kv. winding. This could of course be provided separately.

(3) Reverse-power residual combinations are in general use on the receiving ends of transmission lines. The connections in such an installation are shown in Fig. 4. Both the current and voltage on the reverse-power relays are Y-connected and they are in phase. The residual is set at from 20 per cent to 50 per cent of normal load current, and both are set to trip in a direction out from the station, i.e., back toward the power house.

(4) Reverse-power and directional residual combinations are used on the sending ends of transmission lines, either from a power house or substation. If an overcurrent relay of the common type has its two windings separated as shown in Fig. 5, it will act as a wattmeter whose windings are such as to be actuated

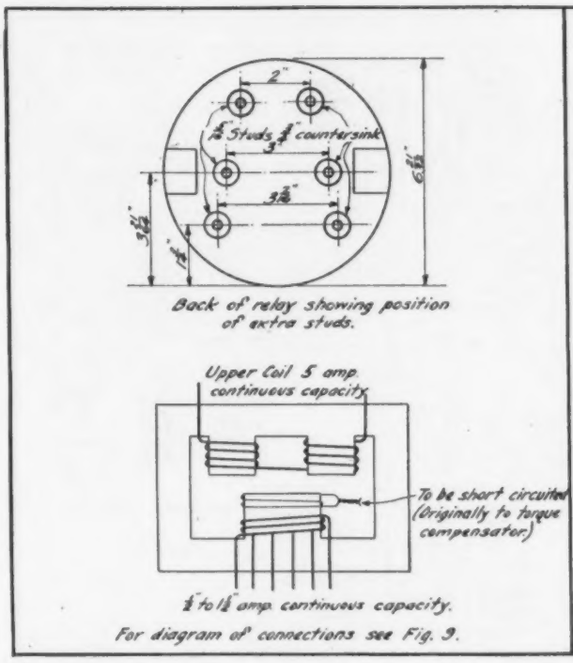

2"
2 Studs ¼" countersink
3"
3½"
3½"
1¼"
Back of relay showing position of extra studs.
Upper Coil 5 amp. continuous capacity
To be short circuited (Originally to torque compensator)
½ to 1½ amp. continuous capacity.
For diagram of connections see Fig. 9.

Fig. 5—Terminal location and internal connections of specially arranged directional CO relay.

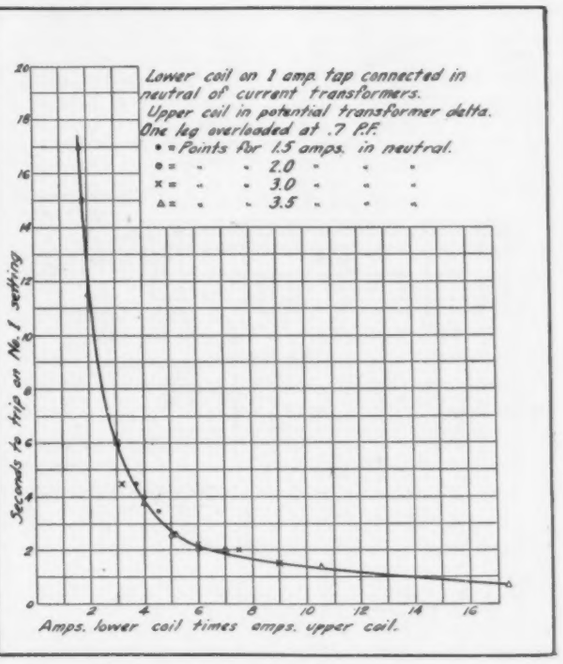

Lower coil on 1 amp. tap connected in neutral of current transformers.
Upper coil in potential transformer delta.
One leg overloaded at .7 P.F.
• = Points for 1.5 amps. in neutral.
○ = " " 2.0 " " "
× = " " 3.0 " " "
△ = " " 3.5 " " "
Seconds to trip on No. 1 setting
Amps. lower coil times amps. upper coil.

Fig. 6—Performance curve of ½/2½-amp. CO relay connected for directional operation as shown in Fig. 5.

by current transformers, with characteristics shown in Fig. 6.

If then it is connected as shown in Fig. 7 it will act as a residual, but in addition will have a direction dependent upon the relative direction of power flow in the ground lead of the transformer and the residual of the line current transformers.

For trouble on a line the power flow may be considered from the line into the ground and back up through the ground lead of the transformer bank. In this case the direction up into the bank from ground is the same wherever the ground on the line occurs, but the direction of residual of the line current transformers depends upon whether the ground is on their bus side or their line side.

This gives a standard direction for one coil of the relay and a variable direction depending on the location of the trouble for the other, both operating on current alone and operating only when there is a ground or unbalance. In addition it can in most cases be set much below the normal line current.

It will be noticed that the relay connections on the sending end of a transmission line are different from those on the receiving end. Because of the power available in the generating plant the power under practically all conditions will be outgoing on all lines, the reverse power relays being set to trip on outgoing power and standing normally closed, function simply as overloads, and non-directional residuals will not select between the line in trouble and the good line.

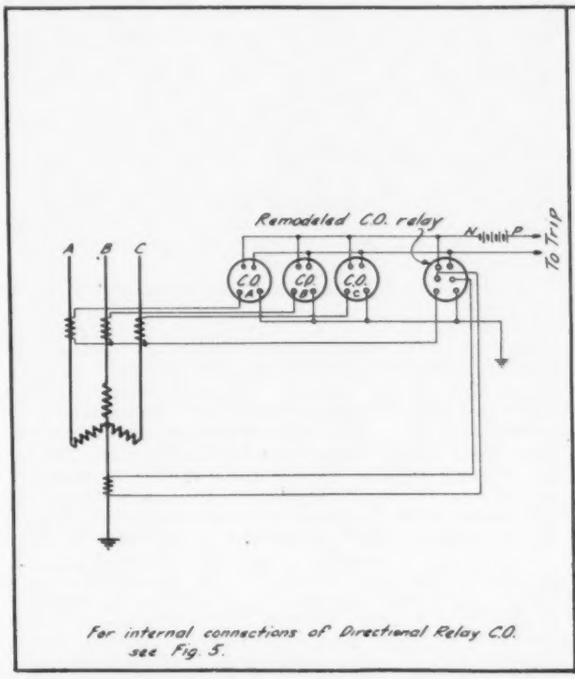


Fig. 7—Diagram of connections for three CO relays and one specially arranged, directional residual-current CO relay.

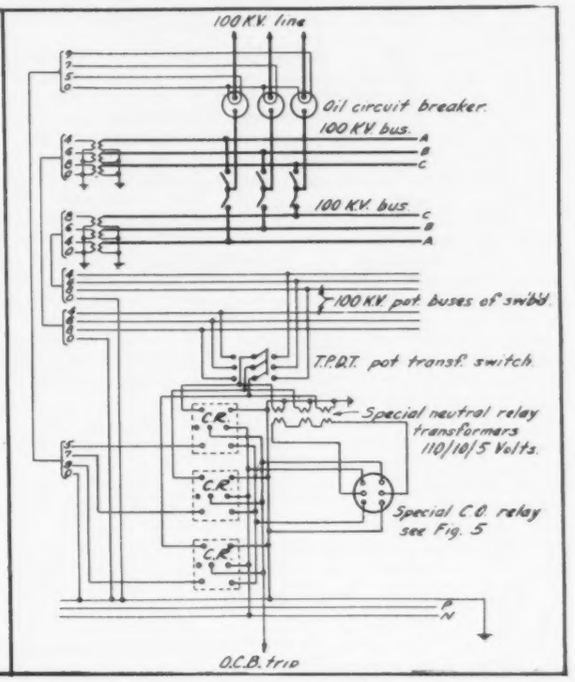


Fig. 8—Complete diagram of connections for combined directional overload and one directional residual-current CO relay.

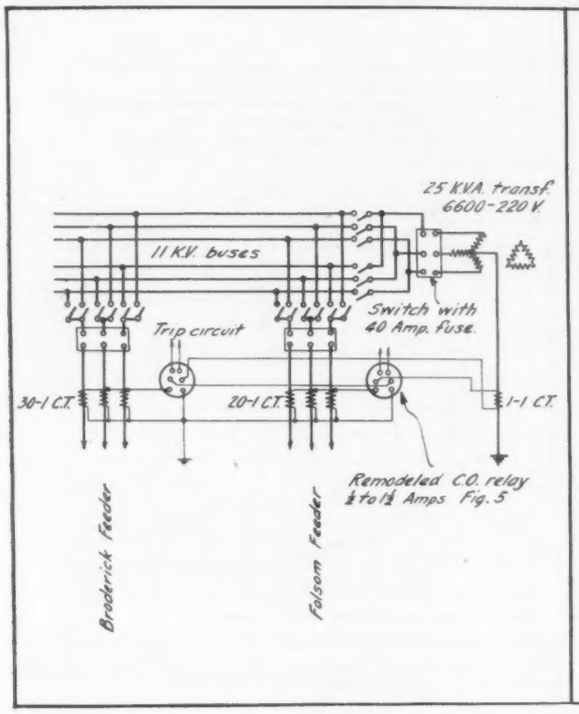


Fig. 9—Diagram of connections for specially arranged directional CO relays for directional residual-current feeder protection.

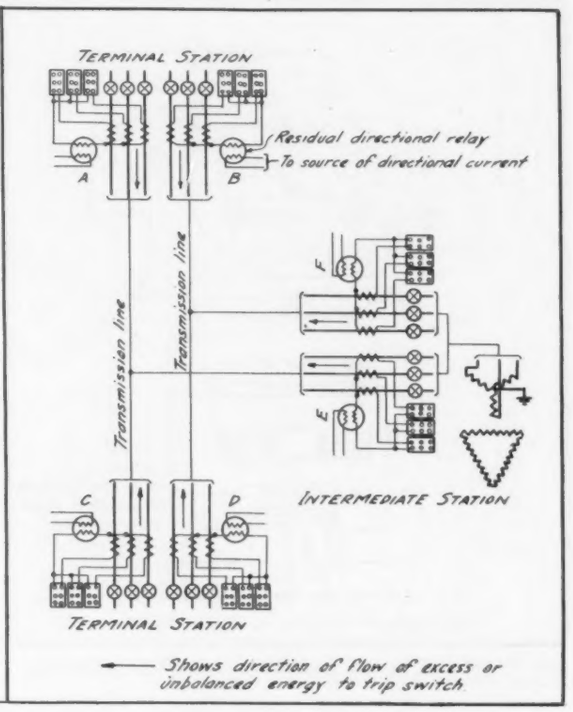


Fig. 10—Diagram of connections for ordinary high-tension transmission line relay protection.

The directional residuals on the other hand will provide the necessary selection. However, it is desirable to retain the reverse-power relays to prevent the possibility of power from feeding back on the good line and tripping it.

On the receiving end of the watt- or directional-element contacts normally stand open and a non-directional residual in conjunction therewith as shown in Fig. 2 and Fig. 4, will provide the necessary selectivity.

The combination of schemes three and four works equally well whether there is one line or several lines in operation, each line being independent of all others. It also allows tapping stations on the line between the two ends without interfering with selective operation.

On the sending ends of certain lines, as at a substation where power is outgoing from an auto-transformer and the transformer ground is not available or is unsuitable, a small 110/5-volt transformer bank is connected in Y to the potential transformer secondaries which also are connected in Y. The primaries of this small transformer bank are Y-connected and the neutral is grounded (see Fig. 8). The 5-volt side of this small bank is connected delta, with the relay coil, which is usually connected to the current transformer in the transformer ground, in series with the delta.

The miniature bank functions just as a large one save that care must be exercised in order to get a very low setting, say 20 per cent of normal, if the line current transformers are of bushing type and of comparatively low ratio. Current settings of less than normal can always be obtained, however. This combination as used is shown in Fig. 8.

In most combinations of the schemes outlined it generally can be stated that the relays should trip on power outgoing from the station (see Fig. 10).

(5) Certain feeders on the network are delta connected and ungrounded. It is desirable to separate these feeders promptly on very light grounds. This is accomplished as shown in Fig. 9, using a 25-kw. grounding bank. As shown, the bank is fused. In practice it was found necessary to relay it for overload at a high current value and a moderately short time-value. As installed, the feeders act selectively on grounds of 15 amperes and have given correct selective operation on 350 ampere grounds.

During one month that an electrically operated dredge was worked off a cable fed by one feeder there were 33 correct operations out of 33 cases of trouble in 30 days where the current to ground ranged from 20 amp. to 350 amp. In two years of operation there has been but one operation classed as questionable.

This same combination (see Fig. 9) is applicable to ungrounded equipment such as generators, and works equally well whether there is one or more than one feeder.

(6) In certain installations, particularly in interconnected substation lines, it has been found that sufficient damping can not be secured on the watt or directional element of the reverse-power relay and still give it effective operation. In such cases it has been necesssary to interconnect the watt and current element of the relay as shown in Fig. 11. In this manner the current element starts to close only after the watt element is completely closed. This is accomplished by putting the watt element contacts in series with the top coil of the current element, leaving intact the winding connected to the current transformer.

In certain cases it also has been necessary to provide for a low tripping current in one direction and a comparatively heavy load current in the opposite direction. This has been taken care of by building a small reactance and shunting it directly across the relay current studs.

At low current values the relay takes nearly all of the current and so can be set for a low reverse value, while at higher values of incoming power the point of saturation on the reactance is passed and most of the current flows through it. A ratio of two or three to one thus can be obtained. The equipment should be calibrated under working conditions. Any changes in current settings on the relay require a new calibration.

In other cases widely differing settings are desired and it is arranged to have a miniature "ratio changer" on the relay taps. Such special cases are encountered only occasionally and must be taken care of in the particular manner which the the case demands.

On the greater number of the system relay installations it is desirable to ring a bell and light a pilot lamp when a relay operates, in addition to the primary function of tripping switches. This is done by using a secondary relay, usually a plunger-type, hand-reset, multiple-contact, circuit-closing type. From experience it has been found that it pays to use the best obtainable.

Necessary Conditions

In order to obtain successful relay operation the questions enumerated below had to be answered by actual trial.

(a) The possibilities of bushing type current transformers came first. These transformers make a high-tension relay system possible and have proved thoroughly satisfactory where currents above 80 amperes are available, if properly applied.

It is advisable always to use relays of a low energy consumption on bushing-type current transformers, with especial emphasis on low ratio transformers. (There are in satisfactory use on the system bushing-type current transformers on transformer terminal bushings where the laminations were cut from sheet

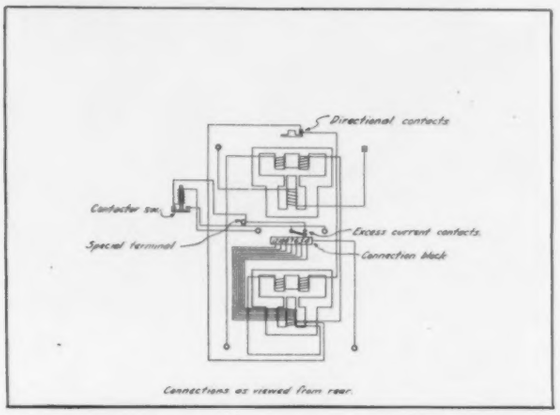


Fig. 11—Internal connection diagram for 7-stud CR relay arranged for control of current element by watt element.

steel, assembled on the bushing and wound in place.) Low-ratio current transformers should not have the secondary overloaded either in volts or volt-amperes. A high-impedance secondary load is fatal to bushing current transformer ratios.

On the system network bushing-type current transformers are calibrated over-all in place by applying current from a 110-220/10-volt transformer through the lead itself or through oil-switch terminals. Each time a current setting is changed this is repeated. Ammeters and indicating wattmeters are in satisfactory use on bushing type current transformers, but preferably should have a separate transformer from that used for the relays. These instruments are purchased with blank scale and are calibrated in place in the same ways as the relays with the addition of a phase shifter to secure the proper wattmeter potential. Any changes in the load on the current transformer secondary, i. e., more or less meters, make it necessary to recalibrate. If meters and relays share a transformer, any changes in relay current-setting make a recalibration necessary.

(b) It has been found by trial that the best operation on the system is had by connecting the current and the potential of the reverse-power relays in phase. This probably is due to the fact that at light loads there is a very low leading power factor, but under short circuit a comparatively high lagging power factor.

(c) All reverse-power relays are single phase. It was found by trial that a three-phase reverse-power relay did not necessarily reverse when only one phase was in trouble.

(d) Differential and directional residual relays should be tested by grounding one phase of the equipment under test and building up voltage until sufficient current is generated at normal frequency to trip. No other method has proved satisfactory.

(e) It is desirable to have relay test switches so arranged that a relay may be cut out of service without changing any wiring.

(f) Proper phase relation of current and voltage, i.e., A-phase current with A-phase voltage is vital to proper reverse-power relay operation. Checking polarity marks or a wiring diagram is not sufficient. The customary method is to use a single-phase wattmeter and apply successively the different voltages to one current. (See A.I.E.E. Journal, 1924, P. C. Jones, "Watt-meter Connections.")

Not all of the schemes and methods outlined above are essential, nor are they the only means of accomplishing the desired results. They are however, accomplishing these results on one of the largest high-tension networks in existence in a fairly satisfactory manner. The chief load dispatcher's statement of correct relay operations on the high-tension network for the two years just past, shown in Table I, bears witness.

Explanation of Analysis

Col. 1. Total Operations Involving Relays—All cases of trouble on the system, which investigation showed involved the relays in service. This comprises the total of the other columns. (Note: Relay operations due to accidental shorting or closing of contacts are not included in this tabulation, nor any failures of a switch to operate due to break, ground, or other fault in the tripping circuit or to mechanical defect in the switch or auxiliary apparatus external to the relay itself.)

TABLE I.—Analysis of relay operation on the 220-kv., 110-kv., and 60-kv. transmission network of the Pacific Gas and Electric Company for 1923 and 1924.

1		2			3		4		5		6	
							Incorrect relay operations					
Total operations involving relays		Correct relay operations			Relay failures		Due to relay		Due to external causes		Questionable relay operations	
Year	No.	No.	Per Cent		No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
1923	1,593	1,490	93.6		24	1.5	11	.7	40	2.5	28	1.7
1924	1,884	1,699	90.2		31	1.6	3	.2	108	5.7	43	2.3

Col. 2. Correct Relay Operations.—All relay operations which have been proved to be correct under the conditions existing at the time. This includes many cases which were not entirely satisfactory from an operating standpoint, but where, owing to load, voltage, and power-factor conditions, it was necessary to credit the relays with correct operation, considering their

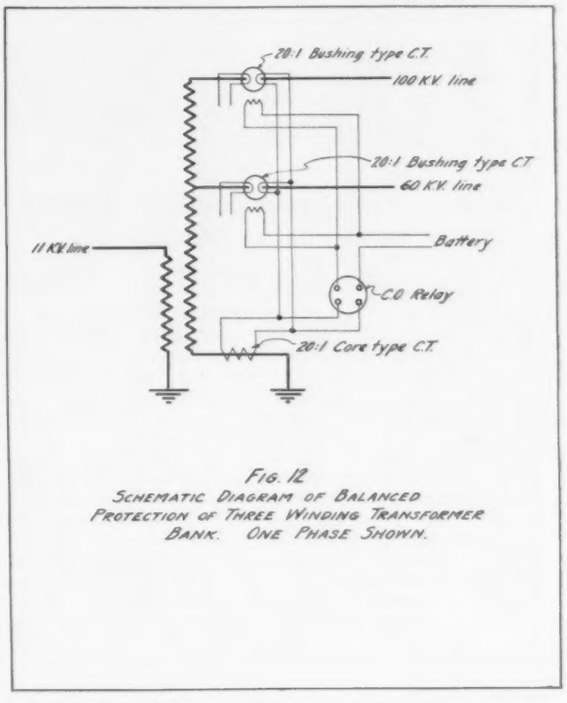


FIG. 12
SCHEMATIC DIAGRAM OF BALANCED PROTECTION OF THREE WINDING TRANSFORMER BANK. ONE PHASE SHOWN.

Fig. 12—Schematic wiring diagram showing balanced protection of three-winding transformer bank. One phase shown.

connections and settings. There also are included here a number of cases where unsatisfactory relay operation occurred due to inadequate equipment. (See also Cols. 4 and 5.) In all cases, however, the relays themselves functioned correctly considering the circumstances.

Col. 3. Relay Failures (No Operation of Switch).—All cases where subsequent investigation has proved that conditions at the point in question were such

as to permit correct relay operation, but the relays failed to function and the switch did not operate. No case of failure of switch to operate is listed in this tabulation if investigation proved the failure to be due to a break, ground or other fault in the d.c. tripping circuit, or to mechanical defect in the switch or auxiliary apparatus external to the relay itself.

Col. 4, Incorrect Relay Operations Due to Relay.—All cases of switch operation that have been proved by subsequent investigation and test to be due to faults, either mechanical or electrical, in the relays themselves. (Note: This does not include relay operations which apparently were faulty because of indequate equipment or improper connections.)

Col. 5, Incorrect Relay Operations Due to External Causes.—All cases of switch operation which investigation showed to be the results of faults or improper connections in auxiliary apparatus external to the relays themselves, or to power factor or other conditions on the system.

Col. 6, Questionable Relay Operations.—All switch operations which it has been found impossible to classify under Cols. 2, 4 or 5. In most cases the operation has been unsatisfactory, but owing to lack of evidence it was considered unfair to classify it as incorrect, particularly as a test made after the trouble showed the relays to be operating correctly so far as could be determined.

Obviously every case of trouble on a network such as the one here under discussion involves a number of relay installations successively distant from the fault, and the proper selection as to the load or time whereby the more remote installations correctly function is not included in this tabulation.

The slight decrease in percentage of correct operation in 1924 as compared with 1923 is attributed primarily to the increased accuracy and thoroughness with which the investigations were conducted in that year, as well as to a considerable increase in the number of relay installations involved.

A departure from the usual practice has been made in the application of the type OX auxiliary relay of the Westinghouse company. The relay is connected so that normally it is latched, and is tripped by applying current to the unlatching coil, and reset by means of the operating coil, thus providing positive mechanical action in closing, with the least possible energy requirement precedent thereto.

Design and Application of System Calculating Board

BY R. C. DENNY

WHILE fully cognizant of the fact that the results derived from a calculating board would only approximate actual conditions and give only initial values, it was thought that the information would be of considerable use because the values would be proportionately correct. It is upon a knowledge of these relative current conditions existing on a system during line troubles that a comprehensive or system-wide plan of relay operation is based. The calculating board described was built up within the year and built to represent a specific generation and transmission-system setup. A front view of this board is shown in Fig. 1. Fourteen generating stations totaling approximately 145,000 kva. tied in on an interconnected transmission network of practically 1,400 miles of 110-kv., 69-kv. and 33-kv. lines. The system generating capacity is augmented by perhaps 55,000 kva., available through interconnections with adjoining systems.

As in most modern calculating boards it is the reactance values of the individual generating units, transformer banks and line sections that are represented by resistance units. The error is thus on the safe side as the current indicated on the various short circuit tests will be in excess of what it actually would be in case of line troubles. As it was desired to operate the board at one certain voltage, the reactance values in the case of the San Joaquin board were reduced to terms of 69-kv. or 40,100 volts to ground which is really the extensive part of the transmission system and that upon which most of the troubles occur. The resistor units are of fixed resistance values and are of the viterous enamel type. There are one hundred and thirty-one of them in all, mounted end on end between the shelves as pictured in Fig. 2. They are held in place by copper rods passing down through them. The selection of the unit resistance value or actual resistance value corresponding to 100 ohms reactance was based upon the rated carrying capacity of certain standard resistors which were very desirable on account of their low cost. This further resulted in a low power consumption and afforded an opportunity to economize on the power unit. Seven hundred and fifty ohms was the unit resistance value chosen and the range of actual resistance for the different classes of units are given in the following tabulation:

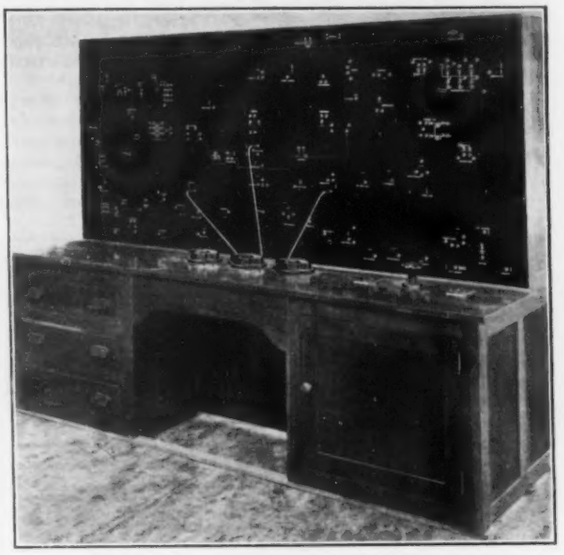


Fig. 1.—Front view of system calculating board used by San Joaquin Light & Power Corporation.

Classes	Number	Ohms of resistors
Line sections	79	9.8 to 774.9
Generators	12	375.0 to 1447.5
Synchronous condensers	3	1,980. to 3015.
Power house trans. banks	13	157.8 to 510.0
Substation trans. banks	16	60. to 1200.
Generators and trans. banks combined	8	1,192.5 to 3232.5

The resistors are connected to jacks on the panel immediately in front of them after the manner shown in Fig. 3. These jacks, some 170 in all, are of the closed circuit type, the springs being separated when a plug is inserted. Three plugs are used; one for simulating short circuits, one for series readings in the several branches contributing to most "shorts" and the third for measuring voltage drop on "shorts" and testing for resistor troubles or "opens."' The jacks used were chosen for their sturdy design and simplicty of mounting. They have unusually heavy bronze springs which insure positive low-resistance contact. Dummy plugs are provided for use when any unit or line on the system is switched out of service. By means of key switches, either of two milliammeter may be switched into the short-circuit cord or the line-series cord and while in the latter the current may be reversed by a third key. The fourth key is for the purpose of switching the voltmeter across the generator or onto the cord for measurements on the board. A condenser prevents excessive arcing on the short-circuit key.

The cabinet itself is 30 x 72 x 96 in. in overall dimensions and is built of quarter-sawed oak finished to match the surrounding office furniture. The size was influenced mostly by the panel which is a standard stock size of ebony abestos material, ¼ x 42 x 96 in. The shelves are made of maple so that withal it is a very substantial piece of equipment. There is ample drawer room in one end while a large door in the opposite end gives easy access to the power unit housed therein. This unit is a motor-generator set comprised of a ½-hp., 220-volt, 1,750-r.p.m., single-phase motor direct connected to a 1/3-kw., 125-volt, shunt-wound generator. The unit rests on felt strips on the concrete floor and is not objectionably noisy. The bench part of the board is 30 in. high and 20 in. wide and has mounted on it the meter

equipment, keys, plugs, rheostat and flush switches. Two milliammeters are used, one having a scale O-2,000 and the other O-800. The third instrument is an O-150 voltmeter.

The transmission system was laid out on the panel as nearly geographically correct as practical, to facilitate comprehensive observations. The lines were ruled on with show-card-writer's ink, different colors being used to designate the different voltages. After the ink had become thoroughly dry the entire face of the panel was given a coat of transparent varnish. Holes for the jacks then were drilled, after which the panel was fas-

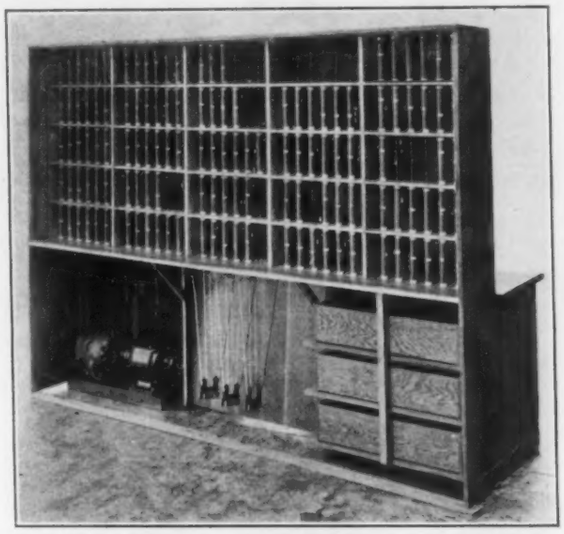


Fig. 2.—Rear view of system calculating board used by San Joaquin Light & Power Corporation.

tened in its permanent position and the jacks mounted. One terminal of each of the resistors representing generators and synchronous condensers is connected to a common bus leading directly to one terminal of the 125-volt generator. The other terminals of such resistors are connected to resistors representing their respective transformer banks and those to the line resistors, etc. The jacks simply are cut in at the junction points so that the cord which is in series with the milliammeter and the other terminal of the generator may be plugged in at any junction point, completing the circuit and

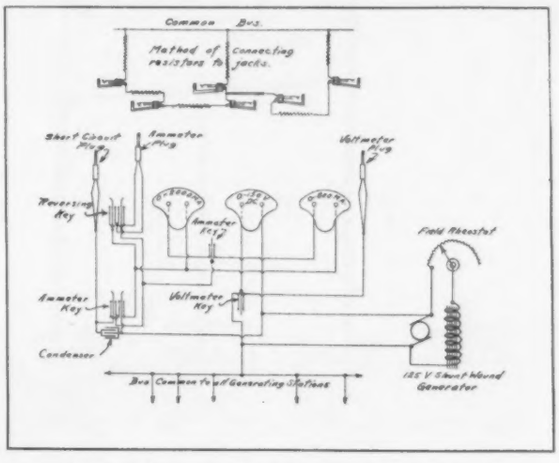


Fig. 3.—Schematic wiring diagram of San Joaquin Light & Power Corporation calculating board.

simulating a "short." Total short-circuit currents as high as 1.2 amp. thus have been obtained.

The current indicated then is multiplied by the constant for that particular part of the transmission system, which is 2,500 for the 69-kv. system with the test voltage held normal at 120. This gives the instantaneous value of the short circuit in amperes from where the time-decay values may be estimated by referring to the proper decrement curves. Such information is what the operating and engineering departments primariily are interested in from the standpoint of the protective-relay system and the rupturing capacity of switches. The board also has proved useful in connection with a study of voltage-drop conditions for three-phase short circuits on the 110-kv. main system-trunk line. It has been demonstrated upon several occasions that inverse-time induction relays are not entirely adequate for this purpose, although they function satisfactorily for single-phase disturbances or grounds. Residual relays are not to be trusted for the purpose. Hence an induction-type undervoltage relay is seriously being considered. This is not the so-called impedance relay, but simply a voltage-actuated relay used in conjunction with the directional type already installed and whose contacts will shunt the current-actuated contacts of the directional relays. It since has been learned that this same system of protection has received considerable discussion in Europe and is in use on two systems in Germany.

Pacific Electric Manufacturing Company Meter Transformer Characteristics

THIS transformer (Fig. 1) is built with a wound primary connected by short flexible conductors to one of the contact brackets and contacts of the circuit breaker, the circuit being diverted through it by an insulating plate between the bracket and the contact. The primary coil can be wound for any ratio specified, the lowest heretofore required being 1/1 or a five-amp. primary and a five-amp. secondary winding. It is mounted on a micanite tube with half-inch wall which

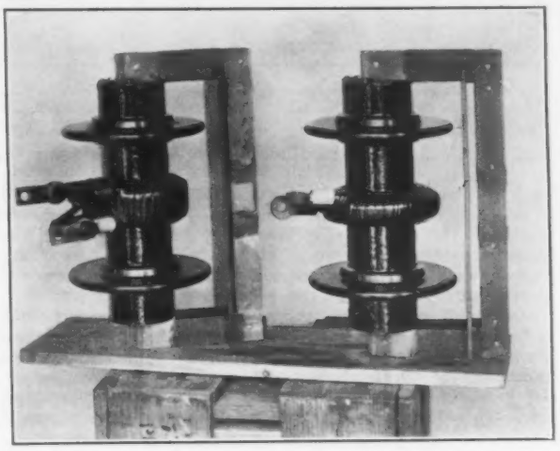


Fig. 1—New design of 70-kv. meter transformer. This transformer is mounted within the circuit breaker tank below the oil level.

separates it from the secondary circuit and the core and on which also are mounted moulded bakelite barriers to increase the creepage distance between the core and the coil. Where the core completes its magnetic circuit around the coil a bakelite plate is set to augment the taped insulation of the primary coil. The core is suspended by a clamping bracket extending downward from the tank top and thoroughly grounding it. The secondary circuit is wound on a fiber tube which slips over the core and prevents injury to the insulation from the edges of the laminations and which with the secondary winding is set inside the micanite tube. The secondary circuit is wound with two parallel wires one of which is of a different circ. mil cross section, thus having a turn or two more than the other and permitting a slight exchange of current. This has the effect of greatly improving the characteristics of the transformer. One each of the terminals of the primary and secondary winding is painted with white enamel for polarity indication so that If the two white or positive terminals are connected together the connection will give an additive polarity.

The characteristics of this transformer have been worked out, and the transformers are being manufac-

tured under certain patents of Otto Knopp, one of the engineers of the Pacific Gas and Electric Company who is engaged in such work and is an authority on transformers.

The standard 70-kv. current transformer is compensated for the useful burden of one watthour meter with leads, giving a total burden of three volt-amperes. The special reactance furnished with the transformer is connected in series with the secondary circuit in the oil circuit breaker. The two cures "AA" (Fig. 2) for ratio and phase angle represent the performance under this condition. The phase angle is small, assuring high accuracy with low and varying power factor.

With the useful burden of 30 volt-amperes and 25 watts (the special reactance remaining in series with the secondary burden), the two curves "BB" represent the performance of the transformer. This condition will prevail when relays, curve-drawing ammeters and other instruments are connected to the secondary. In

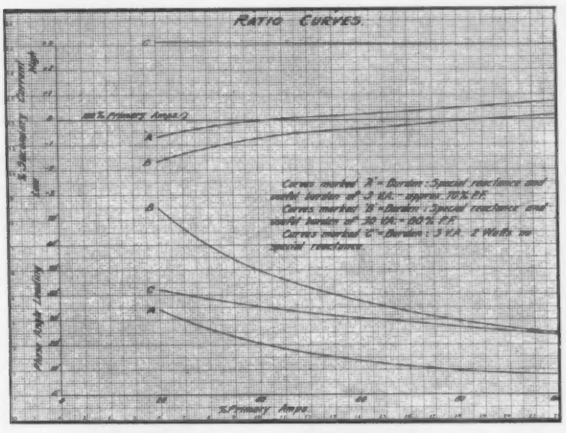


Fig. 2—Characteristic curves of the 70-kv. Pacific Electric meter transformer shown in Fig. 1.

this case the phase angle has no influence upon the instruments.

For special cases where a high line power factor prevails and watthour measurements of high accuracy are desired, the special reactance may be disconnected and the performance shown in curves "CC" obtained with a single watthour meter and leads representing three volt-amperes connected to the secondary.

At high power factors phase angle has very little effect and by adjusting the watthour meter to compensate for the constant ratio error a very high metering accuracy is obtained.

If desired, the transformer can be furnished specially compensated for the above mentioned burden in which case the ratio error will be practically zero, within plus or minus 0.1 per cent.

Automatic Substations on San Joaquin and Affiliated Systems

By E. K. SADLER

THE need to improve service without increasing the cost of operation has been the main reason for installing automatic switch-reclosing equipment on this system. In the case of new substations in outlying districts, the cost of additional property and buildings necessary to take care of an operator is alone much greater than the cost of making the substation completely automatic. The service at substations employing no regular operator, the station being attended by some employee in the neighborhood, has been improved greatly by the installation of automatic reclosing equipment. In other cases it has been found possible to release the operator for other duties by making the substation automatic.

Work was started in 1921 on the first automatic substation on this system. At that time there was no available equipment on the market that could be bought for a reasonable price which was suitable for the needs of the station being planned. The switches for this station already had been ordered. It was found advisable to design completely the needed automatic reclosing equipment and to build this equipment in the company's shops. This designing was handled in the office of C. E. Schnell, electrical designing engineer of the company. The equipment was designed and built at a considerable saving to the company. This equipment was used, with but minor changes to meet the type of circuit breaker installed, at the first five substations made automatic by this company. The same scheme, but redesigned and made by an outside manufacturing company, was used on the later installations.

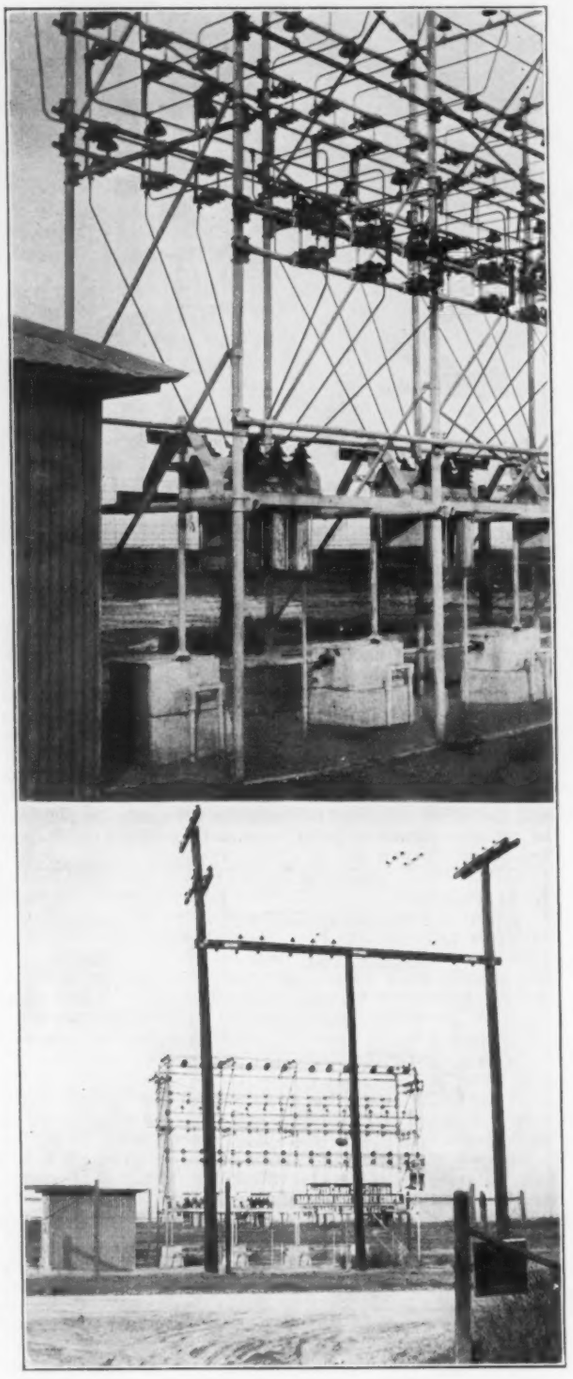


Fig. 1—Shafter automatic substation showing (above) type S-1 reclosing mechanism as installed. The pipe rod extending horizontally between the operating mechanism housings, shown beneath each switch, is the oscillating actuator shaft. Extending from each housing up to an extension of the circuit breaker frame may be noted the rod which is rotated through a small arc by the actuator shaft transmitting the necessary closing motion to the circuit breaker mechanism. Below is a general view of the substation.

Description of this apparatus and its operation will be given in another part of this article.

A brief sketch of each of the automatic substations outlining the reason for making them automatic, the kind of equipment used and records of operation is given in the following text. The substations are listed in the order that they were cut into service as automatic stations.

Shafter Substation

This was a new outdoor-type switching station handling feeders and built on the end of a seven-mile 11-kv. line. It was built in a sparsely settled farming district having considerable pumping load.

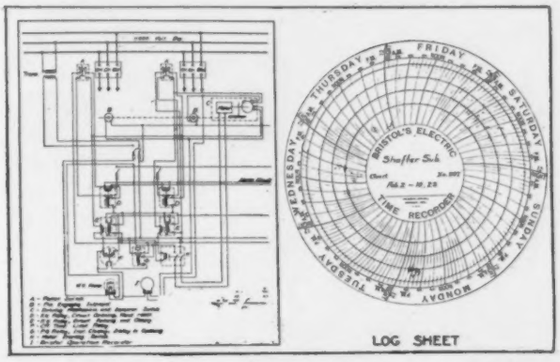


Fig. 2—Showing (left) a wiring diagram of the control circuits for the automatic equipment at Shafter substation, and (right) a reproduction of a typical log sheet. The radial marks indicate circuit troubles.

The circuit breakers were outdoor type FKO-37, 15,000-volt, 400 amperes. The protection was series trip from bushing-type current transformers. The reclosing mechanism is of the reciprocating, gang-operating type. Standard latching and unlatching relays were used in connection with the mechanism. The reclosing mechanism is fully selective. The time interval between closing is two minutes and the number of closings before locking out any breaker is three. All of the equipment is outdoors except the switchboard and driving mechanism.

These are housed in a small building 7 x 8 ft. A complete description of this mechanism will be found in an article by C. E. Schnell in the Electrical World of Feb. 9, 1924.

Although the first installation of its kind on this system, the operation of the reclosing mechanism has been 100 per cent to date. An operation recorder with a seven-day chart and a pen for each circuit breaker keeps the log of the substation. From Jan. 1 to Oct. 31, 1924, the records show 18 kickouts. Of this number three were lockouts being caused by a wind storm shorting wires, crane flying into line burning it down and a tree falling into the line. Although the mechanism was provided with alarm contacts, the cost to run a seven mile alarm line was found to be more than the cost of the automatic equipment so never has been installed to date. The lockout on any feeder circuit is reported to the district office by some customer who has noticed the loss of service.

The only change that has been made in the installation since it was built was to substitute a limit switch, driven by the driving mechanism, for a time limit relay. This was not done because of any trouble, but to remove any chance of trouble. The total cost of this substation including land and 15 per cent overhead was approximately $9,000. The cost of the automatic switch-reclosing mechanism installed was around $2,200.

Los Banos Substation

This substation is a 60-kv. station having four 11-kv. feeder switches. The substation is located in the town of Los Banos. Two of the feeders are quite long and serve a dairy country where many short circuits are caused by cranes and other large birds flying into the lines. The feeder switches are indoor type K-32 B, 15,000 volts, 400 amperes. The protection for them is series trip. There also is a master switch protected by PQ-3 relays. The setting on this switch was made high and it was not made automatic reclosing. There never was an operator at this substation. Notice of kick-out received by an alarm at the company's office several blocks distant, during the day time and at the residence of an employee during the hours the office was closed. In case of a kick-out, it required several minutes for someone to get down to the substation and close the breaker. As there were several creameries

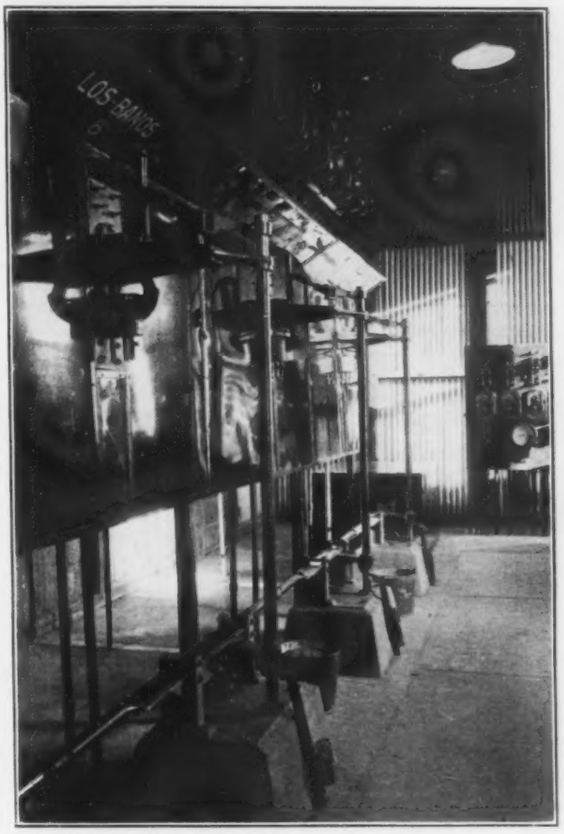


Fig. 3—Automatic switch reclosing mechanism as installed indoors at Los Banos substation. This is one of the earlier installations. In the right background may be noted the instrument panel typical of this class of substation.

supplied with this substation and as any interruption to service lasting more than two minutes was of serious consequence to them, it was necessary to improve the service. It was decided that to install automatic reclosing would be the best way to accomplish this.

The mechanism installed was the same as that at the Shafter station except that the standard latching and unlatching relays were replaced by the type SS automatic switch-reclosing relays. These relays had been developed by the company for use at the California Avenue substation. It was found that with the first set-up of relays as used at Shafter, if one switch should trip out just at the moment that another switch was being reclosed for the third time the mechanism would lock out the last switch that tripped out without attempting to reclose it. The alarm circuit of course would be energized. The SS relays were used in order to remove all chance of any switch not getting its full number of reclosures. Records of operations, however, never have shown the condition mentioned to have happened. For that matter the chance of its happening is so remote that the additional cost of the SS relays may not be warranted in most installations.

The time interval between reclosing at Los Banos is one minute and the number of reclosures before locking out is three.

The log of the substation from Jan. 1 to Aug. 31, 1924, shows 37 kick-outs and only one lock-out. The lock-out was caused by a pole burning down. Mr. Hancock, the district manager at Los Banos, stated that very few complaints were received at his office since making the station automatic compared with the number previously received. Figuring that on every kick-out of a feeder switch there is ten minutes saved in

time of restoring service, due to the automatic reclosing, the saving in loss of power sold due to interruptions amounted to 5,040 kw-hr. from January to September, 1924. The main advantage, however, derived from automatic reclosing is the better service rendered and the therefore more contented customers. The total cost of making the substation automatic-reclosing was approximately $2,700. The increase in the cost at this station over the cost of the Shafter installation was due to the use of the SS relays.

Crane Valley Sugar Pine Substation

This substation was built at the site of our Crane Valley automatic power house. The voltage is stepped down from 60 kv. to 20 kv. to supply power for extensive logging operations several miles distant. The service on this line is very severe, with many short circuits due to the logging operations. The operator lives some distance away from the substation and had many duties to perform other than tending the substation. It required some time for him to get down to

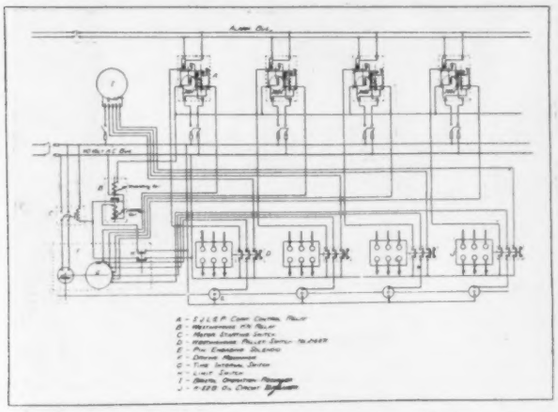


Fig. 4—Wiring diagram of control, operating and alarm circuits of the Los Banos substation.

the station in case the circuit breaker tripped out. It became necessary either to hire another operator or make the switch automatic-reclosing. It was decided to do the latter.

The switch was a 60-kv. Pacific Electric outdoor type, and was installed on the 20-kv. side of the transformer bank. Protection consisted of CO relays in connection with a timing relay so that the breaker would not trip out on overloads of short duration.

As the lumber company was demanding better service at once the reclosing equipment was built in the company shops, being an adaption of the former gang scheme built to operate one switch only. The mechanism was built and completely installed in two weeks' time. Mechanical parts are outdoors under the circuit breaker covered by a weather-proof housing. Relays and operation recorder are mounted on a panel indoors with the other switchboard equipment. The apparatus has operated satisfactorily to date under very severe conditions. The time interval between closings is two minutes and the number of closings before locking out is three.

The log of the substation from April 10 to Nov. 1, 1924, shows 33 kick-outs. Of this number only three were lock-outs. The lock-outs all were due to trees falling into the line. The cost of the automatic equipment installed was $1,050.

Lompoc Substation

This substation on the system of the Midland Counties Public Service Corporation is located in the town of Lompoc and is on the end of a 60-kv. line. The town of Lompoc owns its distribution system and buys power wholesale at 11-kv. There are three other 11-kv. feeders running from this station. One of these furnishes power to the Celite Products Company, the other supplies power to oil fields while the third runs through an agricultural district.

It was decided to install automatic reclosing mechanism on all four feeder switches with provisions for a fifth switch. At first it was intended to retain the operator at Lompoc, the automatic reclosing equipment allowing him to attend to other duties around the district. However, the automatic reclosing proved so successful that the operator was removed from the district altogether. Arrangements were made with the manager of the local power company to look after the station. The alarm circuit was connected with his office and residence.

The circuit breakers are type FK-12, 15-kv., 300 amperes. The reclosing equipment is the same as that used at Los Banos. No trouble has been experienced with the apparatus at this station to date. The log

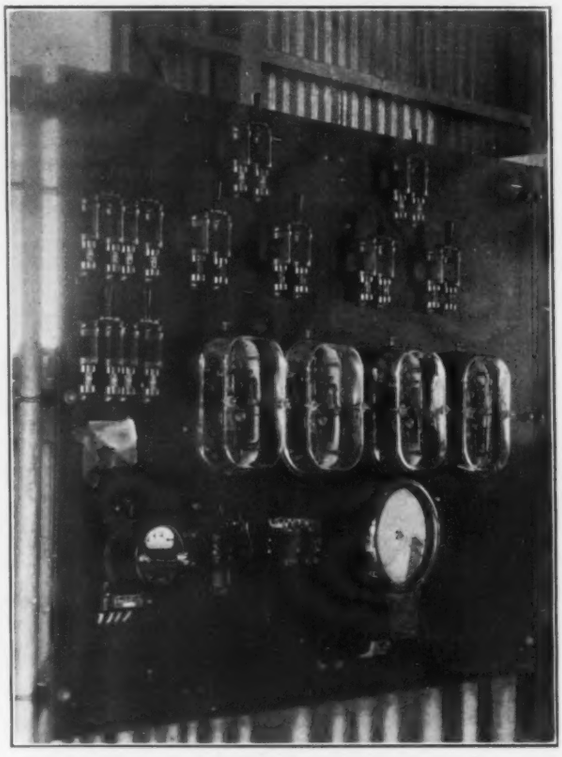


Fig. 5—Control panel at Lompoc substation.

of the station from Jan. 1 to Oct. 12, 1924, shows sixty-one kick-outs. Of this number 12 were lock-outs. This substation is only a few miles from the ocean and the fact that there is considerable fog and moisture in the air a good part of the time accounts for the large number of kick-outs. The total cost of the automatic reclosing equipment including installation was approximately $2,150. This figure includes 15 per cent overhead.

California Avenue Substation

This is an important substation of 18,000 kva. capacity supplying the city of Fresno.

Feeder switches are truck-type, Condit F-10. They are installed in cells and remote controlled. Although three operators are employed here, it was decided to make twelve of the feeder switches automatic reclosing. It was believed that this would shorten interruptions and improve service. At the time this installation was being planned, it was found impossible to secure a relay suitable for this reclosing service. This lead to the development of the SS automatic switch reclosing relay.

This relay is self-contained and to make the circuit breakers automatic-reclosing it was necessary only to mount the relays on the switchboard, one above each control switch. Simply by connecting the relay to the existing control circuit, the feeder switch was made automatic-reclosing. A single-pole switch mounted below the relay provides means for cutting the relay out of service if manual control is desired. The timing of the relay is set at fifteen seconds between closing with three closings before locking out and sounding the alarm bell. This setting can be changed to any interval and number desired, by 15-second steps, up to six minutes.

This equipment has proved very satisfactory, the operators reporting that a feeder switch often trips

out and is reclosed before they could have located the trouble and reached the board to reclose the switch. Several cases of lock-outs at this station also have been reported.

The total cost of this automatic reclosing equipment installed was approximately $2,350.

Le Grand Substation

This substation is on a tap of a 60-kv. line and is located in a sparsely settled district. There is no oil switch on the primary side of the transformer bank. On the 11-kv. side there are four feeder switches and a master switch.

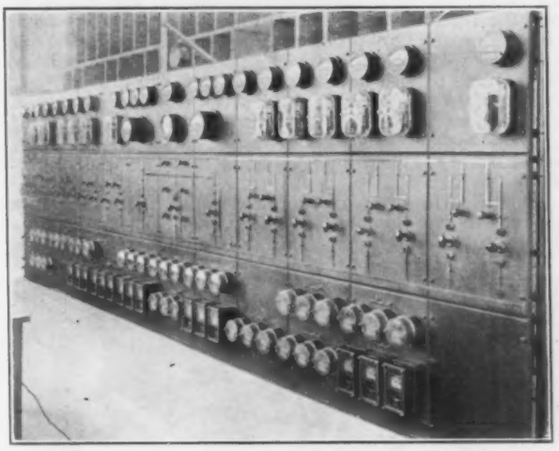


Fig. 6—California Avenue substation 11-kv. switchboard.

The circuit breakers are outdoor-type, Kelman F-6, 15-kv., six-break and are mounted on trucks. All the switching equipment is outdoor type and mounted on a pipe rack. Protection is furnished by CO relays. The switchboard, battery and air compressor are in a small concrete building. This substation is to be an important 110-kv. to 60/11-kv. station in the near future and the 11-kv. switching equipment was built to meet the requirements of the large station. The feeder switches were manually operated when installed.

It was decided to make the station automatic, so air operated mechanisms were obtained from the switch manufacturer to replace the manually operated mechanism. An automatic air-compressor set operated by a 2-hp. motor also was installed. To make the circuit breakers automatic reclosing it then was necessary only to install type SS relays and connect them to the control circuit of the solenoid-operated air valves in the switch-operating mechanism.

The automatic reclosing mechanism has operated satisfactorily to date but some trouble has been experienced with the air-compressor set. This trouble was due to failure of the automatic pressure switch to shut the unit down.

It was attempted to use the telephone line from this station to another station some miles distant, where an operator is employed, for an alarm circuit without interfering with the use of the line for telephoning. This has proved not entirely satisfactory as the alarm bell has rung on several occasions when there was no lock-out at Le Grand substation. This trouble most likely has been due to the fact that it was necessary to keep this telephone line connected with other lines of the system, surges from other parts of the system closing the relay at the alarm end of the line. This relay was of the d.c. type and supposedly connected so as not to be affected by any a.c. surges on the line. On the Los Alamos installation a 20-mile telephone line is used for the alarm and no difficulty experienced. However, this line is cut loose from the rest of the telephone system.

The automatic reclosing apparatus at Le Grand replaced an operator, thus effecting a considerable saving in cost of operation. The saving by using the air-operated mechanism for the heavy duty type circuit breakers instead of a large storage battery also was considerable.

The total cost installed of the automatic reclosing equipment at Le Grand, including the air operating mechanism, was approximately $2,100.

Los Alamos Substation

This substation is on the end of a 66-kv. line of the Midland Counties Public Service Corporation. There are three Condit D-12 15-kv., 300-amp. feeder switches at the substation. The main load on the station is oil well pumping. The station had been built for several years.

It was decided to remove the 60-kv. circuit breaker on the line side of the transformers and tie the transformer bank solid to the line. Protection for the transformers now is obtained by the line switch at Santa Maria substation 20 miles distant. CO relays were installed on this switch for overload protection.

The automatic reclosing mechanism installed on the feeder switches was of the new oscillating type which was an improved design of the former reciprocating mechanism. The scheme of operation is practically the same. The SS relays were replaced in this new layout by simple lock-out relays built specially for use with the new mechanism. The time interval between closing is one minute and the number of closures before locking out is three.

The telephone circuit from Los Alamos to Santa Maria is used as an alarm circuit. This line is run on the same poles as the transmission line. It is cut free from the rest of the telephone system at Santa Maria. Insulating transformers and other protection are furnished at both ends of the line. A double-throw switch was installed at each station so the circuit could be used for alarm or phone as desired. The locking out of any one of the feeder-switch control circuits energizes the alarm circuit with 110 volts a.c. A four-volt bell sounds the alarm in the dispatcher's office at the Santa Maria substation. The dispatcher at Santa Maria can not call Los Alamos substation on the phone, but a party at Los Alamos can get the dispatcher by sending a signal over the alarm circuit. A push button was installed near the telephone at Los Alamos for this purpose. The automatic reclosing equipment did away with the necessity of employing an operator.

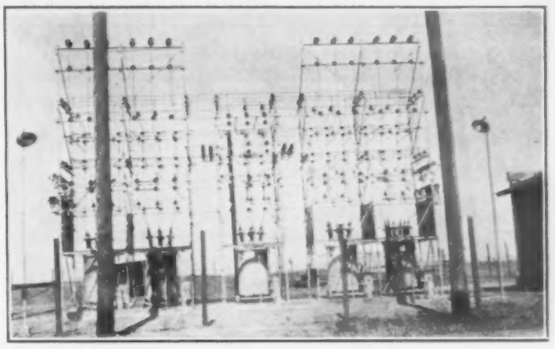


Fig. 7—Air-operated Kelman F-6 circuit breakers arranged for automatic reclosing, Le Grand substation.

The total cost of the automatic reclosing equipment installed was $1,600. Of this amount about $250 was used for installing the alarm.

Paso Robles Substation

A single-switch reclosing mechanism is installed here on a 2.3-kv. feeder switch supplying service to the town of Paso Robles. The mechanism installed is self-contained, requiring no relays and is very simple to set up. The circuit breaker is type K-12 15-kv., 300 amperes. The time between closures is 36 seconds and the number can be set anywhere from one to nine before locking out. Similar to other reclosing equipment, an alarm is energized when the mechanism locks out.

The operator at this station was released for other duties around the town when the equipment was installed.

The cost of the reclosing equipment including labor of installing was only $450.

Three types of reclosing equipment have been used in the above installations. A more detailed description

of this apparatus and its operation is given in the following paragraphs.

Gang-Operating Reclosing Mechanism

This reclosing mechanism will automatically reclose any number of switches up to twelve and is arranged so that should more than one switch trip out at once, no two will be reclosed at the same time. The number of times that a switch will be reclosed, should it trip out repeatedly due to persistent trouble, is optional up to five. Time intervals between closures of 108, 54 or 27 seconds also are optional. If trouble persists after a switch has been closed its predetermined number of times the switch is locked out of the automatic control and an alarm circuit energized. Any switch or switches can be operated by hand if desired, the automatic feature in no way interfering with hand operation. Any spacing of switch handles, from 7 in. on centers up can be taken care of.

All parts are of the sturdiest possible construction and should prove absolutely trouble-proof indefinitely under the most severe operating conditions. All contacts have more than sufficient capacity to handle their loads and one 0.5-kw. transformer is ample to furnish power for the entire installation. About 0.5 kw. also is sufficient, when mechanism is operated by direct current.

This reclosing mechanism consists of the driving engine, oscillating shaft, one magnetic clutch for each oil switch and a panel board. The driving engine consists of a ½-hp., heavy-duty, single-phase motor mounted on a rugged cast iron base on which also is mounted the necessary reduction gears and timing contacts. A heavy sheet-metal cover entirely encloses this assembly with only the driving shaft extending. Thic complete unit can be mounted on or under the floor.

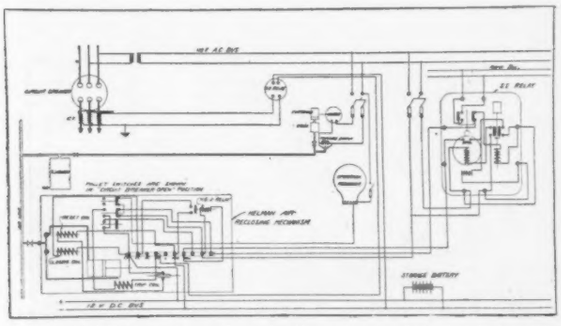


Fig. 8—Wiring scheme for adapting air-operated circuit breakers to control by automatic reclosing mechanisms, Le Grand substation.

The oscillating shaft, driven by the engine through a connecting rod, is installed parallel to the switchboard on which the oil switch handles are mounted. The oscillating shaft also can be mounted on or under the floor or attached to the pipe frame of the switchboard itself. A rod from each oil switch handle extends down to the oscillating shaft to which it is coupled through a lever arm and magnetic clutch. The lever arm is of the proper length so that when the magnetic clutch is energized the oil switch handle will be pushed to the closed position. This lever arm has over-travel at the end of its stroke with a safety device to relieve the oil switch handle and its parts of all undue strain. The closing operation itself is completed in approximately the same time as when done by hand, the exact time being 0.35 sec.

On the panel board are mounted a knife switch for cutting the reclosing mechanism in or out of operation, a latching relay for automatically starting and stopping the engine motor at the proper times and one lock-out relay for each oil switch. The latching relay starts and stops the driving engine through timing contacts driven by the motor gearing. If any oil switch reopens due to persistent overload or short after it has been reclosed the predetermined number of times it is cut out from the automatic control by the lock-out relay which also energizes an alarm circuit.

Operation

A pallet switch is connected mechanically to each oil switch on the back of the switchboard so that when an oil switch trips out it automatically closes its pallet switch, starting the driving-engine motor through the latching relay on the panel board. The engine then rocks the oscillating shaft on which the magnet clutches are mounted. At the predetermined time interval the magnetic clutch is energized and its solenoid, by pulling up its plunger, locks the oil switch handle and its lever arm to the oscillating shaft and the oil switch handle is closed once. If the oil switch stays closed the entire reclosing mechanism operates idly for a short period and shuts down at the end of its cycle, but if the trouble persists and the oil switch opens each time it is closed (for the predetermined number of times) its lock-out relay on the panel board cuts the oil switch out from the automatic control and closes an alarm circuit. This does not in any way interfere with the automatic operation of the balance of the oil switches. When the alarm is answered the lock-out relay knob is pushed down half way to its first stop, thus shutting off the alarm. After the trouble has been cleared from the line the oil switch is closed by hand and the lockout relay knob pushed down all the way, which resets it, and everything is ready to operate as at first.

By the addition of an operation counter it is possible to record the number of times each oil switch has opened and been closed. This can be done in two ways,

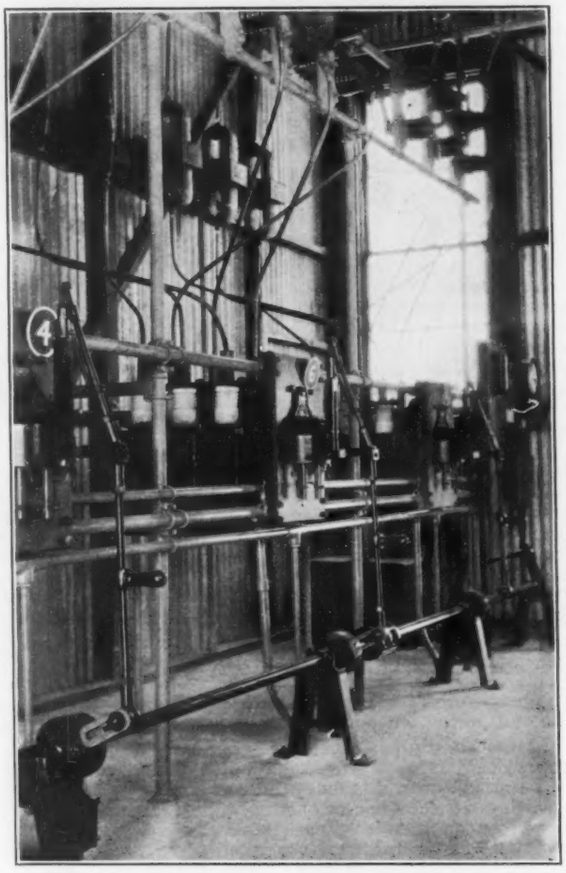


Fig. 9—Type S-2 automatic reclosing mechanism as installed at Los Alamos substation.

either by mechanically connecting a ratchet counter to the oil switch handle or by installing a multiple-pen (one pen to each switch) electrical operation recorder.

On checking up in several instances it has been found that four man-days is ample for the setting up and complete installation (floor mounting) of this reclosing mechanism controlling three oil switches.

Single-Switch Reclosing Mechanism

This reclosing mechanism is for application to single oil switches and will close any switch within the limits of its power. The closing effort is 1,500 in. lb. at the shaft. This closing effort as given is the minimum effort on the shaft when the oil switch is closed. The

mechanism also can be furnished with a minimum effort of 1,000 or 500 in. lb.

The mechanism functions by means of a ¼-hp. single-phase motor compressing coil springs which are released by a cam. When the springs are in their fully compressed position they are under 390 lb. compression. In their fully expanded position they are still under a pressure of 200 lb.

The shape of the cam releasing the springs governs the time interval consumed in moving the switch handle from open to closed position. In the mechanism as regularly furnished this is such as to give a positive closure of the oil switch without violence, but it can be furnished so as to give practically instantaneous action or a delayed action of several seconds.

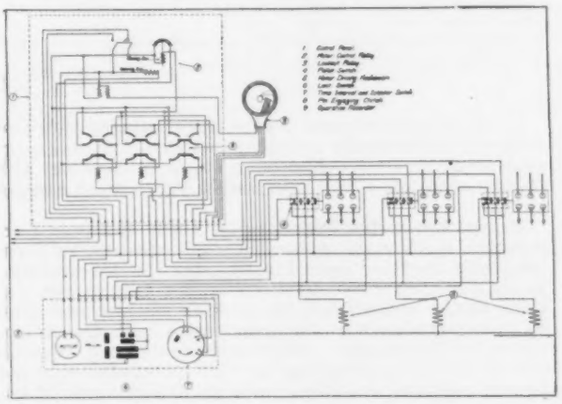


Fig. 10—Wiring diagram for S-2 automatic reclosing mechanism such as that installed at Los Alamos substation.

The number of closings before the mechanism locks out can be anything from one to nine, with time intervals of 4, 5, 9, 18, 36 or 72 seconds between closings.

Power for operation can be obtained from a 200-watt potential transformer. The entire mechanism is enclosed in an iron case 12 x 12 x 14 in. and it can be installed in the back, front or under the switchboard.

The cycle of operation is as follows: The oil switch trips out thereby closing its pallet switch which starts the reclosing mechanism. After a predetermined interval the oil switch is closed and if it stays closed the reclosing mechanism will shut down. If the oil switch trips out again the reclosing mechanism will continue to operate until the oil switch either stays closed or the predetermined number of closings have been tried. The oil switch then is locked out and an alarm circuit energized. When the trouble is cleared the mechanism is cut into service again by pressing down a reset lever.

Installation is extremely simple, merely calling for attaching the pallet switch, running three wires to the mechanism and anchoring it to the floor with four bolts or lag screws.

Automatic Switch-Reclosing Relay

This relay is for application to installations of electrically or air operated (remote controlled) oil switches. The result is that any of the oil switches that trip out are automatically reclosed. Installation merely calls for wires to be run from the oil switch control circuit on the switch board to relay. The existing method of operation is in no way interfered with.

Sequence of Operations

Switch trips out.

Relay starts to operate.

After predetermined time interval relay closes remote control circuit and switch is reset.

Relay returns to starting position if switch stays closed.

Relay does not return to starting position if switch trips out after first closing, but continues to operate.

Switch again is reset by relay after another predetermined interval.

Relay returns to starting position if switch stays in or continues to operate until a predetermined number of closings of the oil switch have taken place, after which—

Relay locks out, closes an alarm circuit and prevents switch on which trouble persists from closing again. Relay can be reset to starting position by hand and switch closed after trouble causing oil switch to open has been removed.

Adjustment of Relay for Number of Closings and Time Intervals

The timing disc on the relay takes six minutes to make one revolution. Near the edge of the disc are 24 holes equally spaced. These holes are made to receive

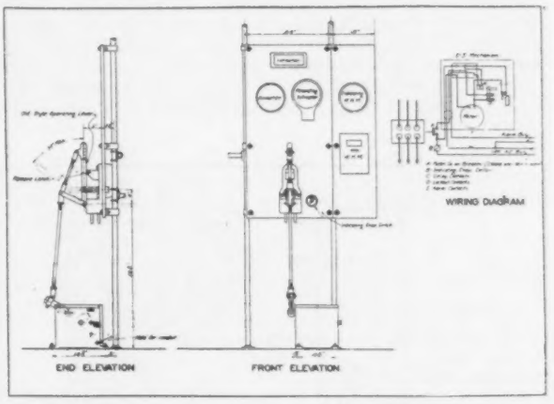


Fig. 11—General layout of single-switch, type S-3 automatic reclosing mechanism such as that installed at Paso Robles substation.

the moving contact pins. The time required for the disc to travel the distance between two of these holes is 15 seconds so any time between closings can be obtained by 15-sec. intervals or their multiple, up to six minutes. One of these holes is made into a slot for the lock-out, and by the moving of a stop pin on the disc to its proper position the relay can be made to lock out after any predetermined number of closings.

Detailed Description of Operation

(1) Operation when the trouble causing oil switch to trip is due to temporary overload or short, which trouble is cleared before the switch automatically is reclosed.

Oil switch 1 (Fig. 1) opens. Pallet switch 2 (Fig. 1) which is mechanically connected to switch 1 closes contacts bb′ (Fig. 1) energizing solenoid 4 (Fig. 1) through lock-out contacts 3 (Fig. 1) which normally are closed. Raising of solenoid plunger 5 (Fig. 1) closes contacts 6 and 7 (Fig. 1). Closing of contacts 6 puts d.c. on contacts 8 and 8′ (Fig. 1), and also energizes clutch magnet 9 (Fig. 1.) Energizing of magnet 9 pulls pinion 10 (Fig. 3) in mash with gear 11 (Fig. 3) which is connected to same shaft as disc 12 (Fig. 1). The closing of contacts 7(Fig. 1) starts motor 13 (Fig. 1) which rotates disc 12 through the gear train. When moving contact 14a (Fig. 1) reaches and makes contact across contacts 8 and 8′ (Fig. 1) the closing-circuit auxiliary relay 17 (Fig. 1) is energized and the oil switch will close. Pallet switch contacts bb′ (Fig. 1) will be opened, solenoid 4 (Fig. 1) de-energized and plunger 5 (Fig. 1) will start to drop. The downward movement of the plunger is retarded by the action of air dashput 18 (Fig. 3.) This delay is adjustable for time. When plunger 5 reaches its lowest point of travel contacts 6 and 7 (Fig. 1) will be opened, motor 13 stopped, clutch 9 de-energized, pinion 10 unmeshed from gear 11 (Fig. 3) by action of spring 19 (Fig. 3). Disc 12 (Fig. 1) will then return to its starting position by action of spring 20 (Fig. 4), pin 21 (Fig. 4) acting as a stop. The tension on spring 20 (Fig. 4) and contacts 8 and 8′ (Fig. 1) are adjusted easily.

(2) When trouble stays on line longer than period required for first reclosing of oil switch:

Oil switch will trip out again. The delay of plunger 5 (Fig. 1) in dropping due to action of dashpot 18 (Fig. 1) will prevent contacts 6 and 7 (Fig. 1) from opening as pallet switch contacts bb′ will close as oil switch trips out and solenoid 4 (Fig. 1) again energized; plunger 5 will rise again to uppermost position. Disc 12 (Fig. 1) will not have stopped rotating but will continue to rotate until contact is made across 8 and 8′

(Fig. 1) by moving contact 14b (Fig. 1), when oil switch again will reclose. If the oil switch stays closed the relay will reset as explained in operation 1. If the switch immediately trips out again the relay will continue to function as outlined in operation 2.

(3) Trouble still is on line after predetermined number of closings of oil switch have taken place:

Disc 12 (Fig. 1) will have rotated until last moving contact has passed stationary contacts 8 and 8′ (Fig. 1), and oil switch has been closed the prescribed number of times and tripped out after each reclosing. Roller 23 (Fig. 2) then will drop into slot 22 (Fig. 2). Lock-out contact 3 (Fig. 1) then will open, de-energizing solenoid 4 (Fig. 1). Contacts 6 and 7 will be opened, motor 13 stopped and gear 11 and pinion 10 unmeshed (Fig. 3). Contact 24 (Fig. 1) will close and energize alarm circuit.

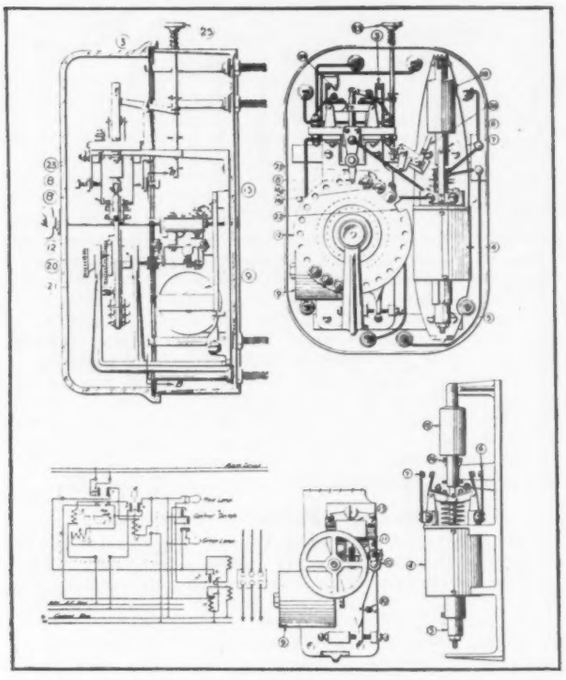


Fig. 12—Automatic switch-reclosing relay. [Referred to on page 485 as Fig. 1.]

(4) Trouble on line cleared and relay reset:

After trouble on line is cleared relay may be reset by pushing down on reset button 25 (Fig. 2) which raises roller 23 out of slot 22 allowing disc 12 (Fig. 2) to return to starting position. Contact 3 (Fig. 1) will close and contact 24 (Fig. 1) open. Bell crank 26 (Fig. 2) holds down plunger 5 so that contact points 8 and 8′ (Fig. 1) will not be energized while disc is returning, which movement is completed in less than one second. When pressure is removed from reset button relay will be in its starting position again and ready to operate as before.

Operating Duty

At present the operating duty on the automatic reclosing circuit breakers on the San Joaquin system are even time intervals. The number of reclosures being in all cases three and the operating duty varying from 15-15-15 seconds to 120-120-120 seconds. It is possible to vary this operating duty to any time interval and number of reclosures deemed advisable.

Maintenance and Inspection

Reports on maintenance and inspection costs of the automatic substations show that these costs are less for the automatic substation than for the manually operated ones. This is due mainly to the fact that the expenses connected with the needs of an operator are done away with. Inspection of the automatic substations is made once a month, the same as the manually operated substations.

Summary

Table I shows the automatic substations in service up to November, 1924. The record of operation given is taken over a period covering the first eight months of 1924.

TABLE I

Substation	Kva., capacity	Sec. volts	Feeders	Months in service	Kick-outs	Lock-outs	Per cent correct operation
Shafter.....	4,500	11,000	4	36	29	1	100
Los Banos...	2,000	11,000	4	20	39	1	98.5
Crane Valley.	1,500	20,000	1	20	36	3	100
Lompoc.....	1,500	11,000	4	16	73	12	100
Calif. Ave....	18,000	11,000	10	12	56	8	100
*LeGrand.....	1,500	11,000	4	9	†	†	
Los Alamos..	600	11,000	3	8	†	†	
Paso Robles..	1,500	2,300	1	4	†	†	

*Capacity since increased to 7,500 k. v. a.
†No record.

In three years of service only three failures of operation of the automatic reclosing switches have been experienced. These troubles were due to a burnt out coil, failure of an air-compressor switch and a weak contact spring.

The policy of the San Joaquin Light & Power Corporation is to make automatic such stations as seem adaptable to this type of operation. So far the majority of automatic substations on the system are stations on the end of stub 60-kv. lines where there is no 60-kv. or 110-kv. switching equipment with the exception of a line switch. Two of the automatic stations are on 60-kv. loops and plans now are under way for two stations where there will be 110-kv. and 60-kv. switch equipment. The plan is to make the feeder switches automatic reclosing and to have one resident operator to handle any high-tension switching.

The experience of this company has shown that the automatic substation not only is a means of improving service, but has reduced considerably costs of operation.

At new substations built in out of town locations where if not made automatic it would be necessary to build a cottage, garage and tank-house for an operator, the additional cost of making the substation automatic is less than half the cost of the building.

Design and Operation Features of Automatic Substations

By R. B. KELLOGG, H. T. SUTCLIFFE and B. D. DEXTER

FOLLOWING are included descriptions of automatic features to be installed in two new substations of this company which are of interest chiefly in that they incorporate features new to Pacific Coast practice. Subsequent to a description of these two stations is a brief description of the automatic regulation on the 11-kv. output of the company's Mountain View substation. This covers the original installation which was put in to regulate the voltage on the secondary side of a bank of three 1,500-kva. transformers, stepping from 60 kv. grounded Y to 11 kv. grounded Y. Since this original installation there has been installed an additional bank of the same capacity, connected in multiple with the first bank. Additional tap-changing switches or regulating heads were installed and connected up to the existing equipment so that the automatic feature applies to the entire output. Although this company has numerous installations where secondary regulation is secured by means of hand-operated tap-changing switches for changing transformer taps under load, the equipment at the Mountain View substation is the only one at present in operation on our system where the regulation is handled automatically.

Automatic Features to Be Installed

During the year 1925 this company will build two new automatic and unattended substations, one located in San Francisco and one in the East Bay District. These substations will incorporate many new and strictly up-to-date features which will prove interesting inasmuch as no similar installations have been made on the Pacific Coast up to this time.

Both stations have been designed for approximately the same service and will be supplied from 11-kv., 3-phase power cables feeding a double bus. The voltage is stepped from 11 kv. to 4.1 kv., 3-phase star through three single-phase, self-cooled transformers. From a 4-kv., low-tension double bus, automatic periodic reclosing distribution feeders supply the surrounding district. These feeders are regulated and operated 3-phase, 4,150 volts, star connected, four wire, with grounded neutral.

Provision is made in each station for the installation of either synchronous converters or motor generators to supply 600-volt d.c. railway service. The buildings are designed as unit type and the 11/4-kv. switchboard and generator rooms may be extended one bay at a time as the growth of load in the district warrants.

With the use of type R.O. street-lighting transformers located on the outside circuits the street lighting equipment in each station is taken care of by practically standard 4-kv. feeder equipment. This eliminates the room and additional electrical equipment formerly required for constant-current transformers in the station.

The ultimate capacity of each station will be approximately 15,000 kva. or 4-kv. distribution, 4,000 kva. of 600-volt d.c. railway service and from three to six street-lighting circuits of 400 kva. each.

Station "L," San Francisco

The following electrical equipment will be installed in this station to take care of the present requirements:

One 11-kv. double-bus and switch structure, one 3-phase, 11/4-kv. self-cooled transformer bank and one unit-type, 4-kv. double-bus and switch structure. The 4-kv. distribution circuits and street-lighting circuits are periodic automatic reclosing.

Supervisory Control—All of the switching in this station is accomplished by the use of supervisory control. The dispatcher's office is located at Station "H," Bay Shore, approximately four miles from Station "L." The supervisory system installed is that known as the distributor type manufactured by the General Electric Company.

The dispatcher will have control keys at his switchboard and may open and close the oil switches at Station "L," receiving lamp indication that the operation has been completed. Each control unit consists of a control key, one red lamp indicating the oil switch is closed, one green lamp indicating the oil switch is open, and one white lamp which will light whenever the indicated position of the oil switch does not correspond with the position of the key. This company has departed somewhat from the standard arrangement of control switchboard in the dispatcher's office and has planned to install a dummy bus in addition to the lamp and key units. This has been done to simplify the switching and to convey to the dispatcher the exact bus arrangement.

Another departure from the standard arrangement of supervisory control has been the addition of a polarized relay for the control of the automatic-reclosing feeder equipments. This relay automatically cuts out the reclosing feature when the dispatcher opens the oil switch, thus preventing a reclosure after the switch has been opened by supervisory control. Should the feeder oil switch open four times and lock out the dispatcher is unable to reclose this oil switch and it is necessary for an attendant to visit the substation, investigate the trouble and reset the lock-out relay. The supervisory relays and control are installed for a single 4-kv. bus only. Transfer from bus to bus is accomplished only manually by means of double-throw transfer switches installed in the substation. This was done to simplify the adaption of supervisory control for a double-bus system where automatic reclosing is employed.

Although there will be no attendant, the outlying station will be equipped with a complete switchboard and control for manual electric operation of all the switches. It was estimated that this could be done at comparatively low expense and would prove a great advantage in cases of emergency such as a break in the interconnecting supervisory wires between the dispatcher's substation and the outlying substation.

Other than that described above, the supervisory system is the manufacturer's standard arrangement and will be described briefly.

The equipment at the dispatcher's office (Station "H") consists of an apparatus cabinet in which is mounted the following:

A distributor with driving motor and polarized relays. This cabinet is wired completely so that the system easily may be extended to supervise 50 devices although only 26 devices (oil switches, doors, control charging sets, etc.) will be controlled at the present time. The relays are mounted in spring clips so that they may be installed easily at any time.

One set of control keys, lamps, phasing lamps, bell, master key, etc., for the control switchboard.

One 120-volt storage battery with middle tap, 60-0-60 volts, with 250-watt trickle-charging motor-generator set and automatic control devices.

One 24-volt storage battery and tungar charging equipment.

The equipment at the outlying station (Station "L") is comprised of the following:

One apparatus cabinet with distributor and relays similar to the one in the dispatcher's station.

One 120-volt storage battery and automatic trickle-charging motor-generator set together with auxiliary switches and detail devices constitute the equipment. The trip-free contactors for relaying the signal to the oil switches and the transfer switches for manual or supervisory control are located on the control panels for each individual oil switch. With this feature the identification of each device with the oil switch which it controls is simplified.

The system operates over four metallic conductors, No. 19 B. & S. gage between stations and in this case will consist of a paper-insulated, lead-covered cable installed the entire distance.

The two distributors revolve continuously and are held at the same speed by a synchronizing device. To perform a desired operation the operator turns the key controlling the necessary apparatus and closes the master operating switch. As soon as this operation is completed the lamp associated with the key turned is lighted, indicating either the open or closed position of the switch in the outlying station. The maximum time between the turning of the key and the return signal (lighting of the lamp) is ten seconds. No impulses are sent out until the master switch is closed. This feature allows a mistake to be corrected before the signal is sent out. When any change has taken place in the position of the oil switches or other devices in the outlying station for other causes beyond the dispatcher's control, indication is given at the dispatcher's office by a change in the indicating lamps and attention is called by the ringing of a bell.

Substaton "E," Piedmont

The other substation, known as Station "E," is much the same in general arrangement as Station "L" in San Francisco except that no 4-kv. distribution circuits will be installed at this time, although the conduit is provided and room allowed for transformers, regulators, and swtching equipment which will be installed as soon as the load conditions demand. This station is located in the residence district and will have an attractive outside appearance and is designed for noiseless operation.

In this station two 1,000-kw. synchronous motor-generator sets, 600 volts d.c. and 11-kv., 3-phase, 60-cycle a.c. will be installed for railway service. These two units will be equipped for complete automatic operation both a.c. and d.c. without manual or supervisory control except for the start and stop operation. In addition to the automatic equipment, supervisory control similar to the system used at Station "L" in San Francisco will be installed for control of the 11-kv. bus oil switches and for the starting and stopping operation of the motor-generator ets. The control switchboard for the dispatcher will be located in Station "L" in Oakland and is similar to that at Station "H" in San Francisco. The d.c. railway feeder circuits will be of the automatic reclosing type with load-limiting resistor and high-speed breaker equipment.

The necessary relays and devices for remote load indication of the two motor-generator sets will be installed at Station "E" and Station "L" to enable the dispatcher to read the load in a.c. amperes on either machine at any time. This is necessary to enable the dispatcher to determine the necessary adjustment of the load and the proper time to stop or start the two motor-generators.

Supervisory stop and start control and lamp indication will be installed for the small motors operating the ventilating fans, battery charging sets and also lamp indication of the open and closed position of the substation door.

In the design of these substations, considering the fact that new and special features have been employed and that there will be no operators, the thought of outstanding importance has been simplicity of wiring and of the location of the different devices. Provision has been made for the testing and tracing of circuit and no interlocks or "trick" connections have been used which

would confuse the maintenance man in locating trouble. Experience has indicated that a complicated station, however successful in its operation, very often proves a menace in case of a loose connection or temporary failure of any of the controlling devices when they are difficult to locate or not properly marked, and the wiring is so complex that a comprehensive identification is impossible when the time is short and service must be restored in lieu of a service penalty.

A modern substation should have plenty of light either day or night and be well ventilated and have convenient aisle spaces. Electrical and mechanical relay apparatus and wiring should be designed to provide suitable protection for satisfactory unattended operation and yet readily be identified and understood. With this accomplished and with simplicty the predominant factor so that relays and wiring may readily be traced and repaired in case of trouble without necessitating an expert, the station will progress from its inception to final turn over with reduced cost and greater speed. Last but not least, when it becomes an operating property, successful operation, fewer outages and reputable continuity of service will result.

Switchboard Instruments and Wiring

By ROY MARTINDALE

THE new Hollywood substation of the Los Angeles Bureau of Power and Light has its switchboard completely equipped with the new rectangular-type instruments. At first glance these instruments look rather odd, but this is merely a matter of having been accustomed to round instruments. Black scales with white markings are used on all instruments on this switchboard.

One particular feature of this board is the use of the three-element ammeter in place of the former practice of a single ammeter and ammeter switch. The actual cost of the three-element meter is but little if any more than the cost of one meter and ammeter switch and their wiring.

By the use of the three-element meter the amount of wiring on distribution feeder panels is reduced at least 25 per cent over the former practice. The meter panel for four 4.4-kv. feeders with ammeters, watt meters and relays now has only fourteen vertical wires. Fig. 1 will give a good idea of the general appearance of this switchboard.

It was not possible to take full advantage of the space-saving features of these instruments because they are adapted to 24-in. panels and the ebony-asbestos panel material used comes in 21- and 42-in. widths.

Design of Automatic Regulator Heads

By J. L. LANDON

AUTOMATIC control on regulator heads first was put into operation on the Pacific Gas and Electric Company system in 1922. At that time there were in service at the company's Mountain View substation three 1,500-kva. transformers, 60/11-kv., Y-connected and grounded both sides, with regulating transformers on the secondary side to give 10 per cent buck or boost in five equal steps. These regulating transformers were

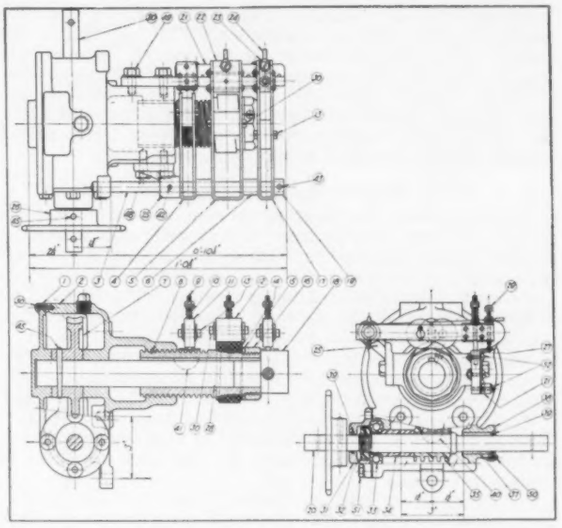


Fig. 1—Showing the assembly of regulator head driving mechanism and cam switches.

hand-controlled, the housing containing the control mechanism standing directly in front of the transformers.

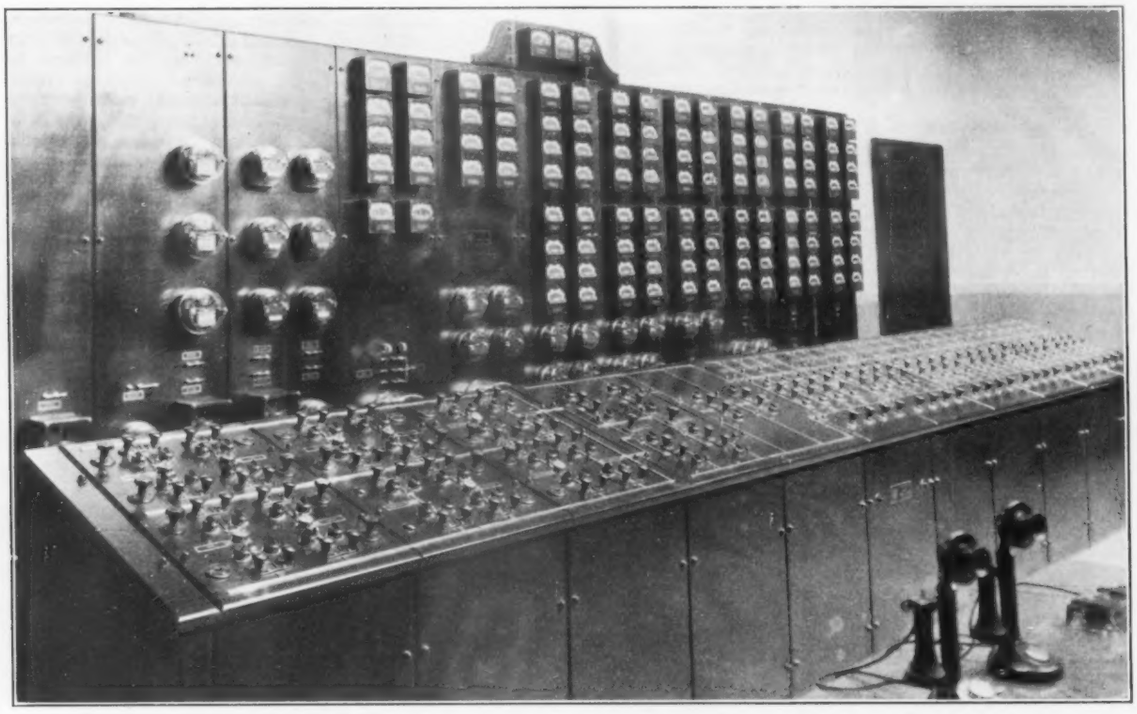


Fig. 1—Switchboard and benchboard at new Hollywood substation of Los Angeles Bureau of Power and Light.

To convert to automatic operation it was necessary to run in front of the regulator heads a jack shaft which was geared to the former hand-controlled shaft and operated by a motor. This motor operation was essentially the same as for induction voltage regulators. A primary relay controlled by a line-drop compensator operated the motor through a motor starter switch. The circuit to the motor is held closed by a timing switch which closes by a cam movement on the driving mechanism of the regulator head until the motor has completed the step change. The introduction of this switch in the circuit eliminated the possibility of the mechanism reversing operation in the middle of the step due to changing voltage conditions. In addition to the timing-switch cam there are two cam contacts which slide along the control shaft on a keyway and open up the control circuit when the maximum position in either direction is reached. Fig. 1 shows the assembly of driving mechanism and cam switches.

Description of Regulator Heads

Figure 2 shows a front and sectional elevation. The frame (1) and housing is of sheet metal reinforced with angle iron. The front and back are removable, making all parts accessible. Contactors (2) have a 500-ampere

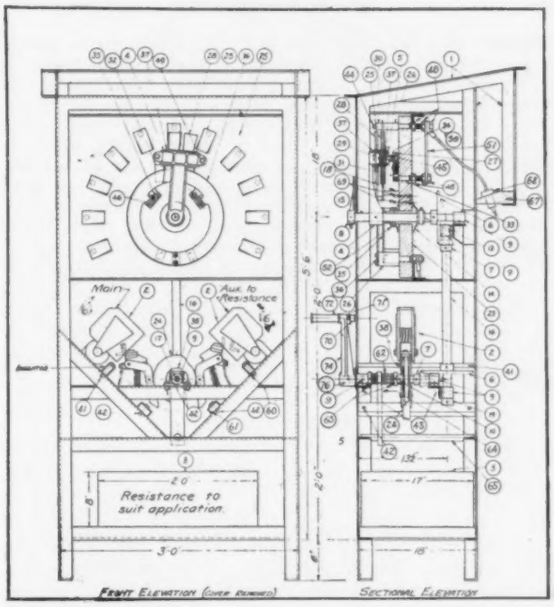


Fig. 2—Front and sectional elevation of regulator head and frame. Front elevation shows appearance with cover removed. When cover is in place contact position is indicated by a pointer arm.

capacity and are equipped with blow-out coil. The resistance (3) is mounted as shown, in the lower part of the frame. It should be of a size and resistance sufficient to give a drop equal to that of one step of the regulating winding at full load.

The contact fingers (28) are of copper clamped to a bronze arm (4) with a copper spacer between to allow a tight fit on the contact blade (25). The main (36) and auxiliary (35) collector rings are of 3/16-in. sheet copper. A brief description of the steps of operation will describe more clearly the mechanism.

Operation of Control Equipment

The operating housing with the panel containing the control equipment is shown in Fig. 3 and a diagram of connections in Fig. 4. A fluctuation in voltage, for example a decrease, will energize the primary relay which will close its contacts for raise. The circuit then is completed through the auxiliary contacts of the controls, which are closed when the main control contacts are open, through the operating coil of the main contacts closing them and through the limit switches for high voltage. (The latter normally is closed but opens when travel in that direction is at an end.) The circuit then is made through the main contactors to two phases of the motor (the third leg connecting directly to the line). This circuit also goes through

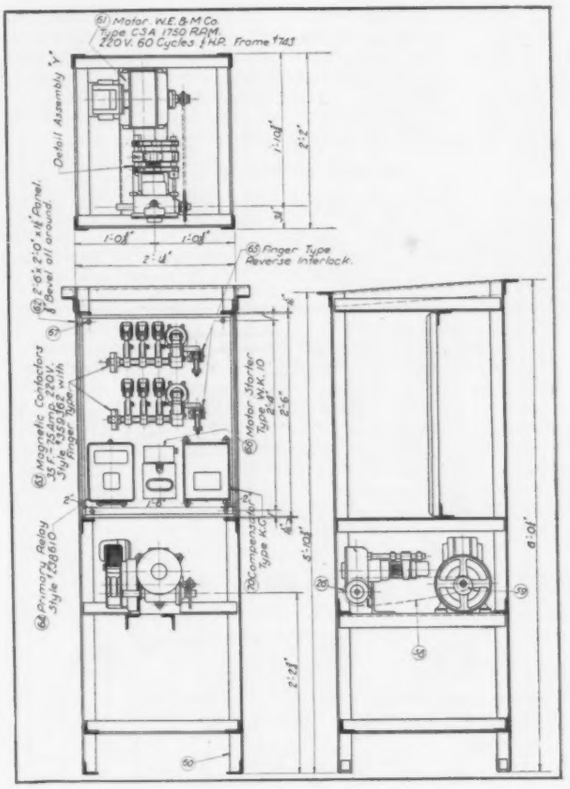

Motor W.E. & M. Co. Type C3A 1750 R.P.M. 220 V. 60 Cycles 1 H.P. Frame 1743
Detail Assembly
65 Finger Type Reverse Interlock.
61 Magnetic Contactors
68 Motor Starter Type W.K. 10
Primary Relay Style 1286610
Compensator Type K.C.

Fig. 3—Assembly of operating housing and panel containing control equipment.

the timing switch which keeps the main contacts closed until the operation is complete, shunting out the primary-relay circuit. To reverse, the same steps are taken and the reversal accomplished by crossing the two phases energizing the motor.

To summarize, there are three separate circuits in the control. The first is through the potential transformer, line-drop compensator and primary relay coil. The second is from a.c. source through motor-starter switch, through primary relay contacts, through auxil-

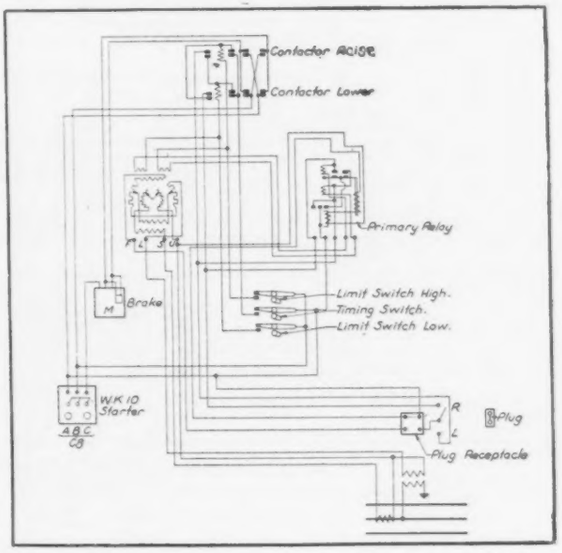


Fig. 4.—Diagram of connections of apparatus shown in Fig. 3.

iary contacts on main relay, through energizing coil for main relay contacts and through the limit switch. The third is through motor-starter switch and main contactors to motor.

There is a plug receptacle through which passes the circuit from the compensator to the primary relay coils. Removing the plug from this circuit and placing it in an adjoining receptacle cuts out the automatic control feature and makes the regulator hand controlled by a knife switch energizing the auxiliary contact circuit controlling the main-relay contacts direct.

Operation of Regulator Head.

Fig. 5 shows the diagram of connections for the regulator head and also a description of the operation. The drawing shows the main finger in position on the neutral contact block. In this position the regulating winding is cut out. The circuit is from the low side of

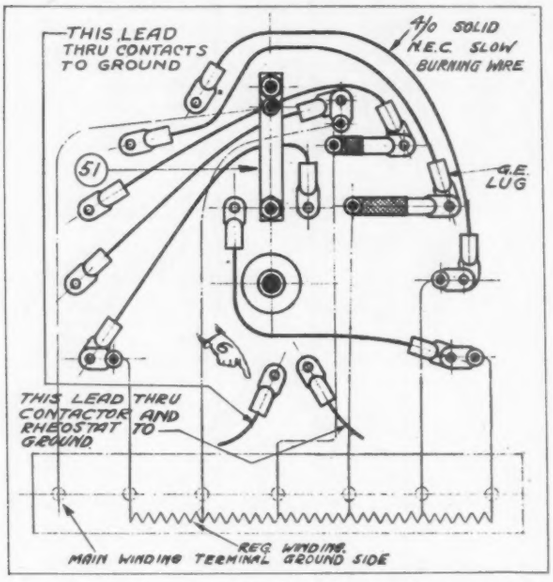

THIS LEAD THRU CONTACTS TO GROUND
#10 SOLID N.E.C. SLOW BURNING WIRE
51
G.E. LUG
THIS LEAD THRU CONTACTOR AND RHEOSTAT TO GROUND
MAIN WINDING TERMINAL
REG. WINDING GROUND SIDE

Fig. 5—Rear view of regulator head showing wiring connections.

the transformer secondary winding through the main contact finger to the outer collector ring and through the main contactor to ground. The auxiliary finger is off the contact block and the auxiliary contactor is open.

When the control circuit operates to raise the voltage one step from neutral the following is a sequence of events:

(1) Auxiliary finger makes contact with block "a".
(2) Auxiliary contact closes.
(3) Reversing switch closes at "B".
(4) Main contactor opens.
(5) Main finger breaks from neutral block.
(6) Main finger makes contact with block "a".
(7) Main contactor closes.
(8) Auxiliary contactor opens.
(9 Auxiliary finger breaks from block "a" and conditions are similar to those at starting. For every following tap, procedure same as above, except that event (3) disappears and reversing switch "B" remains closed.

It is to be noted that the break in the main and auxiliary-finger circuits is made by the contactor blow-

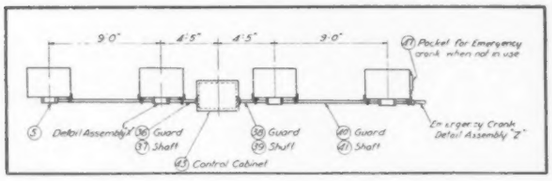


Fig. 6—Plan view of a regulator installation showing schematically the general arrangement of the control cabinet and the operating cabinets for four regulator heads.

out switches. Also to lower voltage one step starting from neutral conditions, the following is a sequence of events:

(1) Auxiliary finger makes contact with neutral block.
(2) Auxiliary contactor closes.
(3) Main contactor opens.
(4) Main finger breaks from neutral block.
(5) Reversing switch closes at "A".
(6) Main finger makes contact with block "a".
(7) Main contactor closes.
(8) Auxiliary contactor opens.
(9) Auxiliary finger breaks from neutral block and conditions are similar to those at starting. For every following tap, procedure same as above except that (5) disappears and reversing switch "A" remains closed.

This sequence is shown graphically in Fig. 5. For protection of this equipment a bell alarm circuit is connected across a section of the grids of the resistance, ringing a bell whenever the regulator operates.

General

This equipment has been almost in continuous operation since its installation. There has been but one case of trouble, which was due to the sliding fingers cutting on the collector ring and causing a heavy drag which broke two teeth out of the top pinion gear. This threw the sliding fingers out of time with the contactor switches which open circuited the load current starting an arc which did some damage to the internal parts.

Some Features of Automatic Generating Plant Design and Operation

BY R. C. DENNY

THE San Joaquin Light & Power Corporation now is operating five hydroelectric plants qualifying as semi-automatic. The generating capacity of the five plants totals 8,775 kw. in five units ranging in size from 475 to 5,000 h.p. and operating under static heads of from 45 to 405 ft. Two of these plants were entirely new developments as semi-automatic plants and employ induction generators directly coupled to reaction type turbines. The other three plants were changed over from manual operation and employ synchronous generators direct-connected to reaction turbines. Four of these plants are operated in series, effecting control of stored water. One of them makes its load-change automatically by means of a float control, while the load changes at the others are made manually at the dispatcher's orders. The fifth plant is entirely independent of any stored water, being a stream-flow plant employing float control.

Safety Features

The automatic features of these plants mainly have to do with the protecion of the apparatus against numerous things that might happen under abnormal conditions. In the plants employing synchronous generators, automatic protection is provided against overvoltage incidental to overspeed should the plant trip off the line. This is accomplished by inserting extraneous resistance in the exciter field circuit. In all plants there are overspeed devices used which function at 10 per cent overspeed to trip the governor safety latch and close the turbine gates either through the governor's operation or directly by motor-operated gearing, as in the induction generator plants.

The bearings are equipped with temperature relays which function to trip the unit off the line and shut it down in case of an overly hot bearing. Troubles either in the generator or in its cables, due to breakdown or to loss of excitation are cleared either by differentially connected relays or by directional overload relays which function to trip first the generator switch and then the field switch. The plants are protected from line troubles either by overload relays of the inverse or definite-time types, usually the former. Governor oil-pressure-system troubles cause auxiliary relays to be operated by means of pressure-operated switches, signaling the attendant. A similar scheme operates in case of governor-belt failures which in some instances would overload the plant. In practically all plants changed over to automatic operation it has been necessary to apply numerous home-made devices in the absence of standard devices. The details of two such original devices designed to effect float-control of load are described.

Load Control

The first and simpler of the two methods of float control is more applicable to plants having little or no forebay storage, in fact no forebay other than a pressure box of some sort to permit spillage incidental to loss of load. In plants of this type the problem of load control is comparatively simple because load

changes result in quick water changes and relatively quick return of the float to normal or neutral position. Referring to Fig. 1, it will be noted that the three wires from the float switch connect with the governor-control motor and its d.c. source through a thermal contactor, which device is nothing more or less than a thermostatic flasher. It is one of the substantial types on the market having heavy contacts and a capacity of 220 watts. The heating element (He) of the thermostat is connected in series with a 60-watt mazda lamp (L) at all times. This results in a continuous though negligible current consumption. The action of the control is as follows:

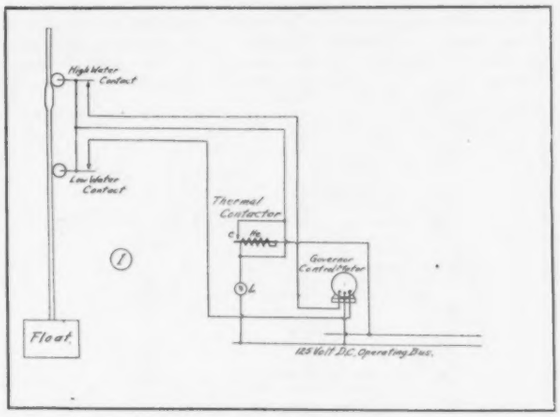


Fig. 1.—Wiring diagram of float control circuits for automatic generating plants having little or no forebay storage.

The current drawn by the lamp through (He) causes the thermocouple to expand and close the contact (C). This shunts out the heating coil and puts the full current through the lamps. The thermocouple then cools off breaking contact (C). This action is repeated continuously, the intervals of closed and open contact being in order of two and three seconds respectively which may be varied by adjustment of the contacts or by using lamps of different wattage. Consider that the high-water contact closes during an interval when contact (C) is closed. Then current will pass through the thermocouple and operate the governor control motor to pick up the load. The contact is then broken in a few seconds as already outlined and the motor stops. If not enough load has been picked up in the first interval to change the float position the motor will operate immediately on reclosure of contact (C). The operation is the same for low-water contact except that the governor-control motor is reversed causing load to be rejected.

In plants that operate on little or no storage the above scheme is very effective as one or two operations usually will be enough to cause the float switch to open. It is quite obvious however that such a scheme would not be satisfactory in forebays of any considerable capacity, as the control motor would operate so many times before the water could draw down or rise enough to break contact that the governor would greatly overtravel one way or the other. Therefore the method shown in Fig. 2 was devised to give greater time intervals than was possible with any thermal device. Relays L, H, I and D are standard plunger-type relays of well known manufacture, all of current-operated type, three-ampere rating. All except (D) are of the instantaneous-type relay, (I) having a third contact and flexible connection to the plunger contact. (D) is of the definite-time-delay type. The long-time-delay relay also is standard although not in extensive use owing to the rather special nature of its applications. The explanation of this method of operation follows:

Consider that the high-water contact closes. This puts a.c. on relays (H) and (D). Relay (H) picks up, instantly putting d.c. on the governor-control motor through contact (A) to pick up some load. Obviously the motor must not operate too long, or far too much load would be picked up. Relay (D) in the meantime is coming up to close its contacts in a definite time of two or three seconds or whatever is found to be the proper interval. Immediately upon closing its contacts three things are accomplished simultaneously. Energy is maintained on (I) through contact (B) and flexible connection entirely independent of relay (D), and holds in. Relay (D) is shunted out and opens, taking its normal position. The long-time-delay relay starts due to the action of the synchronous motor which is energized through contact (B). Contact (A) opens at once and stops the governor control motor. All this happens within two or three seconds after the float first contacts.

The motor (M) continues to operate moving the arm (Rm) around for a definite time of five or ten minutes or anything up to 25 minues that may be found necessary to allow the forebay to draw down. At the end of this interval, contact (B) is opened by the lever (Rm) and, provided that the high-water contact has broken in the meantime, motor (M) stops and the lever (Rm) resets. Also relay (I) is de-energized, taking its normal position and breaking the shunt around relay (D). However, if not enough load had been picked up and the high-water contact still is maintained, the governor control motor will start immediately when contact (A) recloses and relay (D), receiving energy immediately on having its shunt broken begins to time the operation as before. The operation for low-water contact is just the same except that relay (L) is operated instead of (H) to reverse the governor-control motor to reject load.

Of course it is possible to rebuild clock mechanisms to accomplish results similar to those obtained through the methods just reviewed. However, it is very doubtful if the same ease of control over the short and long-time delays could be had without getting into quite a complicated and expensive machine. The manufacturers rapidly are coming to realize the need of such devices and it soon will be possible to change over a plant and use all standard devices.

Underlying Reasons for Changes

The principal reason for changing over the three synchronous unit plants was to cut down operating expenses by eliminating two operators at each plant, and the reason for the two induction unit plants was to so simplify operations that the one reservoir attendant at each place could safely assume the responsibility of supervising operations. All these plants operate at a very low yearly load factor owing either to their intermittent or seasonal operation in connection with the use and control of stored water or to variable stream flow. For these reasons the operation could not be economically effected unless the labor charge was reduced to a very minimum. It was felt necessary to keep one man at each plant on account of the considerable property at each place to be looked after, therefore the semi-automatic nature of the installations. Although the man at each plant is paid more to assume the entire responsibility the net saving in labor

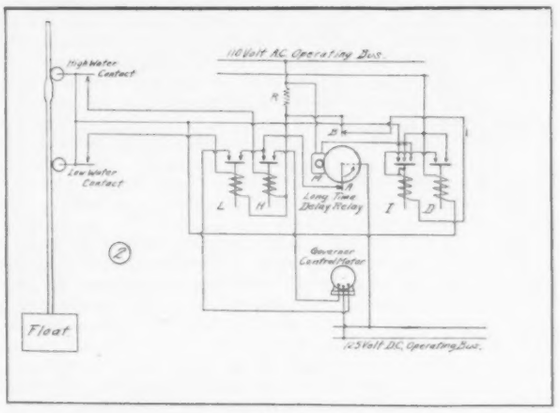


Fig. 2.—Wiring diagram of float control circuits for automatic generating plants having forebay storage.

is $205 per month per station or $12,300 per year for the five plants. In regard to the time of so called expert supervision in connection with such plants as is often heard mentioned, it may be said that the operator is so instructed as to be able to keep the various relays and devices in operating condition which is more in the order of keeping contacts clean, and battery charged

up than anything of a highly technical nature. Expert supervision is therefore a negligible percentage of the kw-hr. cost.

Supervisory Control

Owing to the fact that there is a man stationed at each of these plants there is no occasion for the use of any entire scheme of remote supervisory control. The success of such a control system is dependent on the infallibility of the control circuits. As these are subject to the same difficulties as the transmission lines and which in turn affect the plants it is reasonable to expect that the control would on many occasions be out of order just at the time when most needed. If the plants were of an entirely automatic nature, then remote supervisory control would be necessary and cable circuits probably justified. There is one case however, where water is admitted to a ditch by remote operation of gates in the dam and the height of water in the ditch indicated back to the operator a distance of a mile by means of a standard long distance pressure indicating system. In another case the output of one plant is indicated at another plant where operators are on duty constantly. In this case the distance is perhaps a half mile and the indication by a wattmeter where the output is stepped up to transmission voltage at the larger plant. There is no control involved, merely an indication of load and the load changes that the remote plant makes automatically. These are the only cases which in any way approach remote control or supervision of operation in connection with the semi-automatic plants.

Ground-Current Control and Station Electrical Grounds

By F. H. MAYER, D. J. KENNELY and H. L. SAMPSON

THE question of correct design and installation of station grounds is misunderstood more generally than any other electrical term used in connection with station layout. There is a wide difference of opinion in what constitutes a good ground. Most articles and discussions heretofore have dealt principally on surface area of plates or rods necessary for contact with the earth and a special effort usually was set forth to show the best method and material to be used in order to obtain the least possible resistance from conductor to earth.

It is recognized that these facts all are important, but in view of the fact that these points have been discussed thoroughly, it was thought not necessary to discuss this phase of the subject any further, but to rather take up the matter of station-ground layout as it applies to Southern California Edison power houses and substations.

There has been published very little on grounds and control of stray currents in station layout and therefore, as a result of such a condition, many stations are being designed and installed without being given the consideration that this branch of design should have. Very often we read where instruments on the switchboard were burned out or some part of the building or the plumbing was damaged to considerable extent, all as the result of some electrical failure. This in our judgment can be avoided to a very large extent, at least it can be confined to the area in which the failure occurred if the correct design is adopted. This naturally suggests just what constitutes a good ground layout.

As the result of experience with the 220-kv. ground layout and also as a result of the methods used on our substation ground-control system, it is the opinion that in order to have a good ground layout there must be five points satisfied, namely:

(1) Will it protect human life?
(2) Will it protect vital parts of the electrical equipment, such as switchboard equipment, etc.?
(3) Will it permit the equipment installed to function as it is supposed to, for example lightning arresters and relays?
(4) Will it keep the potential in a station down in relation to other stations in case of a flash-over to ground?
(5) Will it protect the steel and concrete in the building where conductors of heavy carrying capacity are supported on the building structure?

It is believed that when considering the above points there are three fundamental considerations to be taken into account:

(1) The current on the occurrence of an accidental ground always passes or tends to pass from the point of failure to the generator or transformer neutral, or a point of weaker insulation on the other phases.
(2) The potential gradient of an energized conductor when placed in the ground possibly may be quite pronounced.
(3) The current will seek the path of least resistance.

In order to satisfy the first consideration, any flashover from phase to ground, foreign to the station, will have its circuit satisfied if the neutral of the power transformer is tied to pipes or embedded plates that are inserted in permanent moisture. For flashover near the station or on the station proper, due to the difficulty of grounding each piece of equipment to the earth, it was found more economical to tie each piece of equipment to the neutral or transformer case by a metallic conductor. This introduces a lower resistance path from any point of possible failure to the neutral than is possible through the earth's surface. It was found in ground layouts that when a metallic path was formed from various parts of the rack structure to the ground neutral there was a considerable net work of copper. When this net work was properly placed it was possible to take care of the second consideration. In all layouts care is taken that immediately below steel structures, such as braces, a conductor is embedded in the earth's surface. Any steel such as columns is similarly treated.

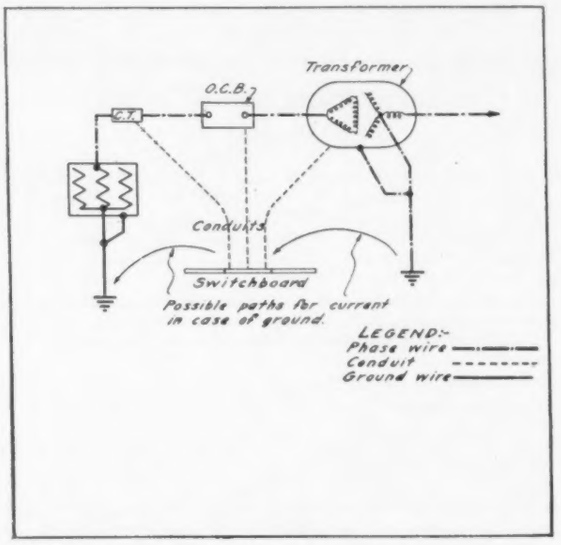


Fig. 1—Schematic wiring diagram of condenser or generator and power transformer each with neutral grounded to earth. No metallic control.

For the third consideration, so far as the outdoor racks are concerned, this condition has been satisfied provided the net work has sufficient carrying capacity to reduce the resistance to the required amount. However, on substation or power house layouts where there are several racks or a rack and a building precautions should be taken to shunt out the switchboard that controls the various groups with conductors of extremely low resistance thus discouraging any current from going through the vital part of the station.

Figure 1 shows a single line diagram of the condenser or generator with its individual transformer bank and with the neutral of the condenser, generator and transformer grounded to the earth. The dotted line represents secondary wiring such as current-transformer secondaries, temperature alarms, and other circuits. Upon the occurrence of a failure on the low side of the transformer experience has shown that in order to satisfy the circuit when a station is grounded similar to this, current will flow from the failure to the case of the transformer, through the secondary wiring or the conduit, through the switchboard and back to the

generator or condenser. This probably happens for the reason that the resistance through the ground path is the higher of the two.

Figure 2 shows a single line diagram with the installation which is typical of recent practice on unit installations such as occurs at Laguna Bell, Eagle Rock and Big Creek No. 3 and also for the fourth unit at both power house No. 1 and No. 2. The conductor, which is tied to the neutral of the condenser or generator, is run parallel to the main leads and each insulator supporting the main leads is mounted on steel inserts. These inserts are bonded to this heavy cable, which extends the full length of generator or condenser leads,

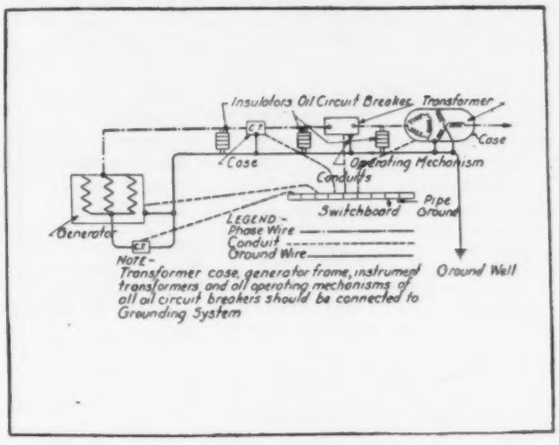


Fig. 2—Schematic wiring diagram of condenser or generator and power transformer each with neutral tied to metallic control.

and is tied to the frame of the generator and to the case of the transformer. This conductor usually is about 75 per cent of the carrying capacity of the generator lead. It is true that a lower carrying capacity would carry the current during the short time of flow at the time of trouble, but if a high resistance were used there might be sufficient potential developed to cause enough current to flow through the switchboard to do considerable damage. There were several cases of trouble, one at Laguna Bell and one at Big Creek No. 3, where an insulator failed. In every case the differential relays opened the circuit breakers and the damage was very slight. At Laguna Bell the ground cable was burned slightly and the walls blackened as a result of the arc. At Big Creek No. 3, six minutes

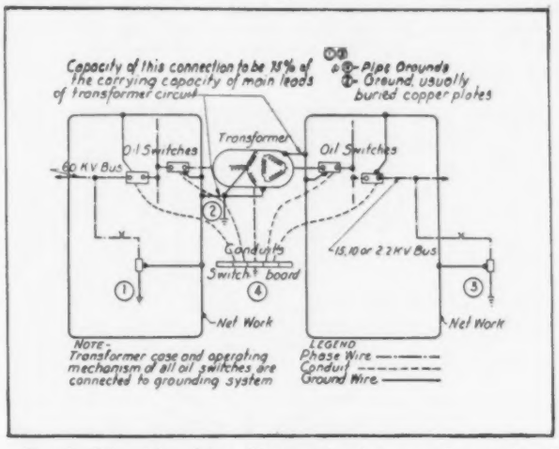


Fig. 3—Schematic wiring diagram showing ground control and grounds for 60/10 or 2.2-kv. substation.

after the flashover the machine again was placed back on the line. A very slight damage was done to the insulators and later, when operating conditions permitted, the insulator that flashed over was replaced. A thing surprising to the operators in charge was to find that notwithstanding the seriousness of the flash at the point of failure, there was not a single piece of equipment damaged on the switchboard or any other place.

The lead to the ground well in Fig. 2 need not be any larger than as dictated by the high-tension conductor.

Figure 3 shows diagram which is typical of 60-kv. to 15- or 10-kv. racks. The solid line shows the net work, the dotted the main circuits. No. 2 represents the ground well, which usually is made up of plates inserted in permanent moisture. The solid line connects the 60-kv. net work to the case and usually is made up of two No. 4/0. Two conductors are preferable to insure a connection from the 60-kv. net work to the transformer in case one should become severed. The conductor that ties the 15-kv. net work to the case usually is of lager

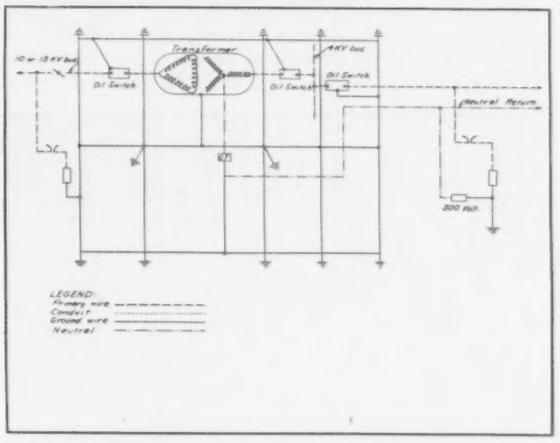


Fig. 4—Schematic wiring diagram or ground current control and grounds where transformer case and operating mechanisms of all oil circuit breakers are connected to grounding system.

conductivity than the one leading from the 60-kv. It may be two No. 4/0 or larger, depending upon the carrying capacity of the main transformer secondary leads. The grounds shown on No. 1 and No. 3 are pipe grounds for lightning arresters.

Figure 4 shows the typical layout used for 10- or 15-kv. to 4-kv. substations. This consists of a net work with pipes driven at various points throughout the net work and the 4-kv. neutral return tied to the transformer neutral. The lightning arresters on the 4-kv. usually are placed at the first pole. Three 4-kv. lightning arresters are directly tied to grounded pipes driven into the earth at the foot of the pole. In addition to this, a 300-volt arrester is tied to the neutral return. The lightning arrester on the 10 or 15 kv. is located at the station and therefore is tied directly to the net work. In addition to the grounds at the station, the neutral return is grounded with pipes driven at various points along the line.

This in a brief way outlines recent practice. Since the adoption of this system of grounding there has been not a single indication of dangerous conditions about the substations and power house premises. Therefore it is believed that the fundamentals as outlined are very nearly correct.

Station Grounds on the San Joaquin System

By H. N. KALB

ON all power systems using a Y connection on transformer banks the quality of the ground connection is an important feature. Even with delta banks the ground connection is an important feature if a ground detecting device is used. Just how good this ground connection may be often is a much debated question and if trouble arises the usual recourse is to add ground connections until it is believed that again it is safe for all conditions. The types of grounds used are many and consist of everything from a single galvanized-iron pipe driven into the earth and connected to the grounding lead by means of solder or a copper ground clamp, to an elaborate net work of driven pipes connected together with a net work of copper wires covered with charcoal and other porous material and provided with water pipes to keep the surrounding earth moist.

Solder is a good agent for making connections provided a good firm mechanical connection first is made

and a good job of soldering is done so that the metal surface are well tinned over an area sufficient to prevent fluxing of the solder when a heavy ground current is experienced. Soldering a wire to the inside of a pipe is the poorest kind of a connection and should not be used under any circumstances as the solder may be melted entirely away from the wire and pipe at a time of an abnormally large ground current and the ground connection entirely lost without any knowledge of what has happened.

Various methods of measuring the ground resistance have been tried with varying success. One of the methods used is the so-called three-point method. This consists of the main ground to be tested and two temporary grounds, the three forming as nearly as possible

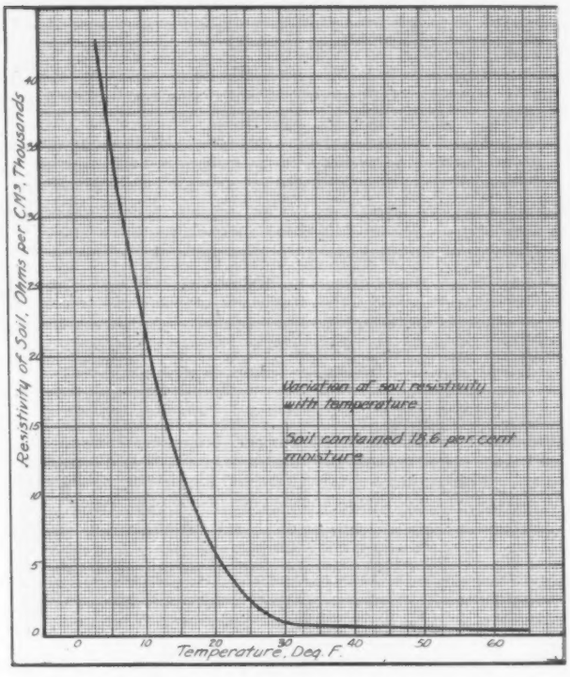

Resistivity of Soil, Ohms per C.M., Thousands
Temperature, Deg. F.
Variation of soil resistivity with temperature
Soil contained 18.6 per cent moisture

Fig. 1—Variation of soil resistivity with temperature. Soil contained 18.6 per cent moisture.

an equilateral triangle. Current then is passed through two grounds at a time and the current readings and the voltage drop taken. From these values the resistance in each of the three sides of the triangle is figured.

However, in most stations all the grounds and neutrals are tied together and it is the total result that is interesting and not the contact resistance of one individual ground. The ground return resistance, in the case of Y-connected banks with the neutral grounded, consists of the earth return between stations in parallel with the resistance of the transmission line wires which are in series with the high voltage windings of the station transformer. In measuring this resistance with direct current the impedance of the transformer windings are neglected. If the d.c. measurements are to be used, the resistance can best be measured by the use of a portable bridge with a 2-m.f., 1,000-volt a.c. condenser connected across the terminals of the bridge. Where there is a telephone line between the two stations, the telephone line can be shorted and grounded at one end and the bridge with condenser placed between line and ground at the other end and the resistance measured directly. For safety it is well to insert a choke coil between the telephone line and the portable bridge. A good choke coil is the highly insulated winding of a telpehone insulating transformer with the other winding open. These transformers have a low-resistance but high-impedance winding, making ideal protection. The characteristics of the station transformer always are on record and if a closer check is desired the impedance of the winding can easily be figured for each case. If only a general condition of the station grounds is desired, the d.c. bridge measurements are adequate.

A number of tests have been made with both the

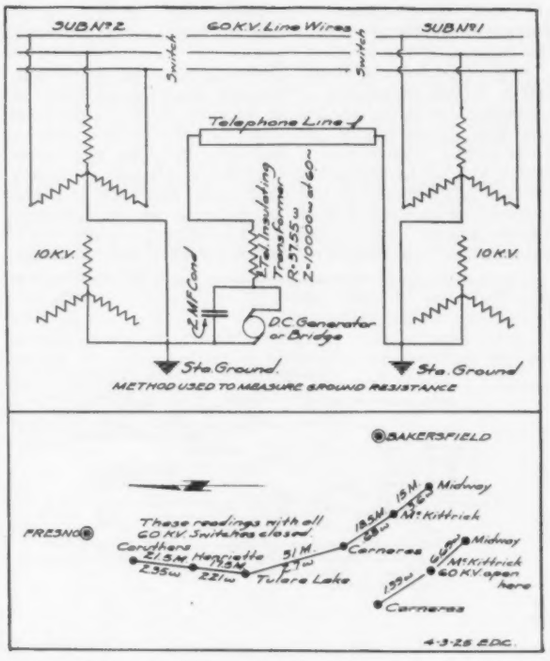


Fig. 2—Schematic diagram showing location of and method of making ground-resistance measurements.

portable bridge and a small motor-generator set and they check very closely. These tests have been made mostly between substations and with the following results: (See Fig. 2.)

Miles between substations	Ohms in ground return
21.5	2.35
17.5	2.21
31.0	2.70
18.5	.68
15.0	3.60

These results indicate that these stations are provided with adequate grounds, provided that the contact area is sufficient to prevent a burning of the earth that is in contact with the metal ground. If sufficient heat is generated at the contact between the metal and the earth, fusion results and an insulating substance somewhat similar to glass often is formed. This may not occur with a ground, but the earth next to the metal may be sufficiently dried out and parched so that it forms a very

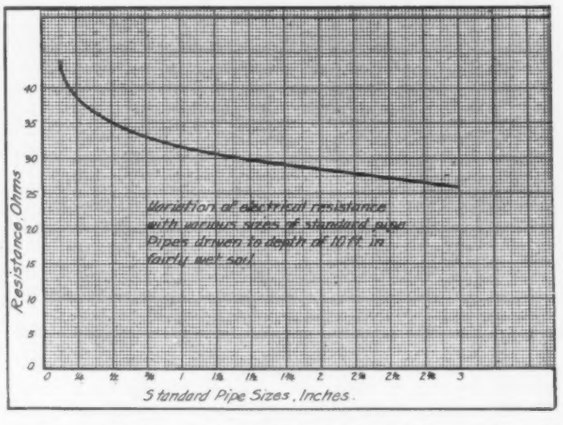

Resistance, Ohms
Standard Pipe Sizes, Inches
Variation of electrical resistance with various sizes of standard pipe. Pipes driven to depth of 10 ft. in fairly wet soil

Fig. 3—Variation of electrical resistance with various sizes of standard pipe. Pipes driven to depth of 10 ft. in fairly wet soil.

high resistance. This would indicate that grounds should be designed for contact area just as switches are designed and with the same thought in mind.

In an article by H. M. Towne, of the General Electric Company, published in the Electrical World of Jan. 26,

1924, a statement is made that the capacity of a good average ground pipe driven 10 ft. into moist, moderately salted soil is from 5 kw. to 20 kw. This is for a ¾-in. pipe. For larger pipes the capacity should increase in proportion to the increase in the contact surface of a larger pipe. It is believed that most companies use pipes larger than ¾ in. for station grounds because of the greater contacting area and consequent mitigation of the danger of drying out the earth enough seriously to affect the ground resistance. The curves shown in Figs. 3, 4, 5 and 6 also were taken from Mr. Towne's paper and show very clearly the effect on ground pipes under various conditions of moisture, temperature, size and depth. From these curves it seems logical to conclude that with a moisture content of 20 per cent a ground temperature of 32 deg. F. or higher, and the pipe driven to a depth of 10 ft. or more a first class ground will be provided which does not vary to a great extent with the size of the pipe. The size of the pipe will determine the contact surface and the capacity in amperes that may be obtained without the earth drying out at the point of contact with the pipe.

In making tests for ground conditions along the south and west sides of the San Joaquin Valley, use was made of a 4-ft., ⅝-in. ground rod with a long tapering point and also one with a blunt end. These tests were made during the last of July, 1924, when the soil was extremely dry. The soil was light silt with a very small quantity of fine sand and a trace of alkali. Whenever the tapered rod was driven a ground was obtained at once but if it was turned slightly the contact was broken completely and a slight tap of the hammer was necessary to restore the contact. Anything to cause pressure of the earth against the ground rod was all that was needed. It was very difficult to get a good contact with the blunt ground rod.

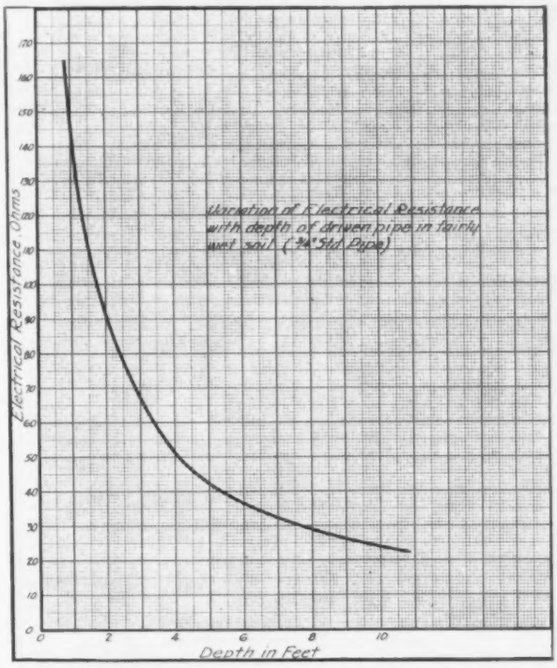

Electrical Resistance Ohms
Depth in Feet
Variation of Electrical Resistance with depth of driven pipe in fairly wet soil (¾" Std. Pipe)

Fig. 4—Variation of electrical resistance with depth of driven pipe in fairly wet soil (¾-in. standard pipe).

In the Nov. 28, 1924, report of the apparatus committee an appendix gives the report on a very interesting test of ground resistance with per cent of total voltage drop at the tested ground, showing that 82 per cent of the drop occurred within a distance of 1 ft. of the ground pipe. These tests were made with 6-ft. ground pipes, but the intermediate readings were taken on rods only 1 ft. in length. If anyone has made a similar test, but with the use of 6-ft. rods for the intermediate readings, a comparison of results would be interesting.

In conclusion, good station grounds should be designed for the necessary carrying capacity as might be determined by a set-up on a system calculating board. Provision should be made to keep the moisture content of the soil above 20 per cent and the ground pipes should be placed to a depth of 10 ft. or more. If multiple grounds are used, they should all be provided with means of keeping the moisture content above 20

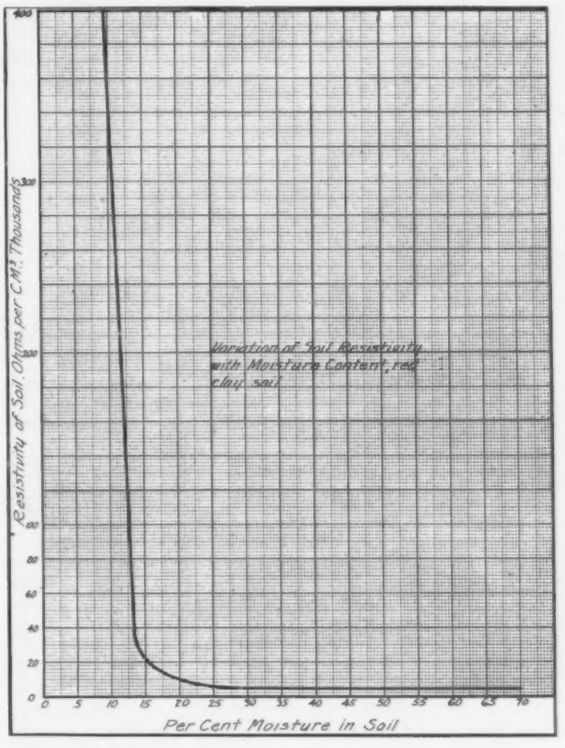

Resistivity of Soil Ohms per C.M.³ Thousands
Per Cent Moisture in Soil
Variation of Soil Resistivity with Moisture Content, red clay soil

Fig. 5—Variation of soil resistivity with moisture content (red clay soil).

per cent. The use of salt around the ground pipes always is advisable and if the pipes are well galvanized, corrosion should not give a great amount of trouble. This would be taken care of through the yearly tests as recommended in the report of this committee of Nov. 28, 1924.

Stations Grounds on Pacific Gas and Electric Company System

By B. D. DEXTER, H. S. LANE and H. T. SUTCLIFFE

IN general it is the practice of the Pacific Gas and Electric Company in the construction of new stations to provide separate grounds for the various classes of duty, such as the grounding of power transformers, switch and bus frameworks, building frames, switchboards and instruments, segregating these into currrent-carrying grounds and static grounds. To current-carrying grounds are connected power transformer neutrals, both primary and secondary, neutrals of the high-tension sides of current and potential transformers, generator neutrals and other such points. To static grounds ordinarily are connected switch and bus frameworks and similar structures, building frames, neutrals of current and potential transformer secondaries, switchboards and conduits, neutrals of 110/220-volt transformer secondaries and instruments cases.

The above classification is general only and is not strictly adhered to in all cases. In some cases, one of which will be described later, where ground conditions particularly are favorable and a high-safety factor assured, all connections are made to the same ground. In other cases where ground conditions particularly are unfavorable, the apparatus connected to the static ground may be still further segregated so that the switchboard and building frame together with apparatus attached thereto may be grounded to a ground

separate from everything else. Where lightning arresters are installed they usually are grounded separately. No rigid standard of grounding has been adopted as it has been found necessary to make practice flexible enough to permit adoption to conditions met with in individual installations.

Regarding the size of conductor used, in no case is a conductor smaller than No. 4/0 allowed for the current-carrying ground and in general a conductor is used

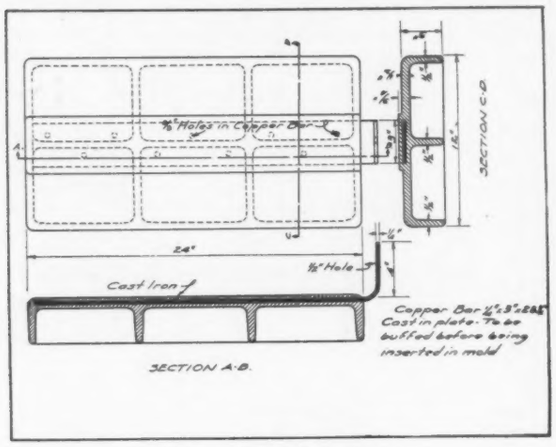


Fig. 1—Cast iron ground plate.

which is sufficiently large to carry the maximum ground current possible under any conditions. The size of the conductor to the ground contact surface or in other words the ground plate, is figured with the same idea in mind.

The standard ground plate as shown in Fig. 1 generally is used although in special cases well casings or other forms of ground plates may be utilized.

Representative grounding systems of recent construction are shown in Figs. 2, 3 and 4. These are particularly with reference to the grounding systems installed by this company.

Claremont Substation

There are at Claremont substation, constructed in 1922, a bank of three 10,000-kva. transformers and a bank of three 667-kva. transformers stepping from 110 to 60 and 11 kv. There are on the high-tension side of these banks two 110-kv. oil switches used for bank protection and five 110-kv. oil switches for sectionalizing and switching the 110-kv. lines entering and leaving the station. On the low-tension side there are the usual 11-kv. feeder switches, switchboard and auxiliary apparatus.

The current-carrying ground at this station consists of three 500,000-circ. mil cables in multiple running to eight standard cast-iron ground plates set in the bed of the northeast arm of the East Bay Water Company's Temescal reservoir. The distance between the station and this ground is 425 ft. approximately, and the conductors are enclosed in fiber conduit for practically the entire distance. To this ground are connected the primary neutrals of the 110-kv. transformer windings, including the potential transformer primary neutrals. It also is used as a static ground for all of the yard structures, including the tanks of all of the high-tension switches. The secondaries of the 110-kv. potential transformers also are connected to this ground. In addition to the eight ground plates above mentioned, one plate is placed under one foot of each switch tower and connected into the net work as an additional precaution. The low-tension grounding system consists of 4/0 leads leading from this station a distance of approximately 550 ft. to two cast-iron ground plates set into the ground beside a spring. This ground is on the opposite side of the station from the current-carrying ground and both grounds are outside of the station property. To this ground are connected the building frame, switchboard, conduits, instrument cases, current and potential transformer secondary neutrals, 11-kv. oil switch tanks and mechanisms, disconnect switch bases, lighting transformer cases, and other similar points.

South San Francisco Substation

The layout of the grounding system at this station, constructed in 1924-25, is shown in Fig. 5. It will be noted that there are four grounding systems here employed.

(1) The 60-kv. power or current-carrying ground to which are connected the 60-kv. neutrals of the transformer banks. This ground is connected to four standard cast-iron ground plates. To this also are connected the primary neutrals of the 4-kv. potential transformers.

(2) The 4-kv. current-carrying ground to which are connected the 4-kv. transformer neutrals and which also is grounded by means of four standard cast-iron plates.

(3) The ground to which is connected the 60-kv. structures and which is a static ground connected to four plates.

(4) The static ground to which is connected the building frame, switchboard, conduits, current and po-

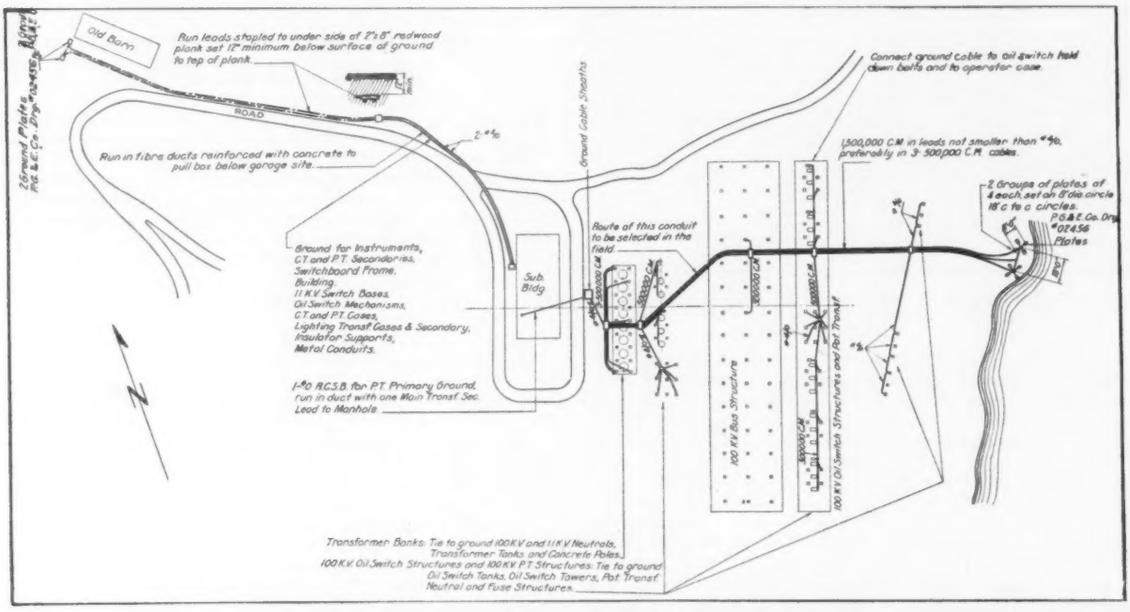

Old Barn
Run leads stapled to under side of 2"x8" redwood plank set 12" minimum below surface of ground to top of plank.
ROAD
Run in fibre ducts reinforced with concrete to pull box below garage site.
Ground Cable Sheaths
Connect ground cable to oil switch hold down bolts and to operator case.
(500,000 C.M. in leads not smaller than 4/0, preferably in 3-500,000 C.M. cables.
2 Groups of plates of 4 each, set on 6' dia. circle 18' c to c circles.
P.G.&E. Co. Dwg. #02456 Plates
Route of this conduit to be selected in the field.
Sub. Bldg.
Ground for Instruments, C.T. and P.T. Secondaries, Switchboard Frame, Building, 11 K.V. Switch Bases, Oil Switch Mechanisms, C.T. and P.T. Cases, Lighting Transf. Cases & Secondary, Insulator Supports, Metal Conduits.
1-4/0 R.C.S.B. for P.T. Primary Ground, run in duct with one Main Transf. Sec. Lead to Manhole
100 KV Bus Structure
100 KV Oil Switch Structures and Pot Transf.
Transformer Banks. Tie to ground 100 K.V. and 11 K.V. Neutrals, Transformer Tanks and Concrete Poles.
100 K.V. Oil Switch Structures and 100 K.V. P.T. Structures. Tie to ground Oil Switch Tanks, Oil Switch Towers, Pot. Transf. Neutral and Fuse Structures.

Fig. 2—Arrangement of ground cables at Claremont substation.

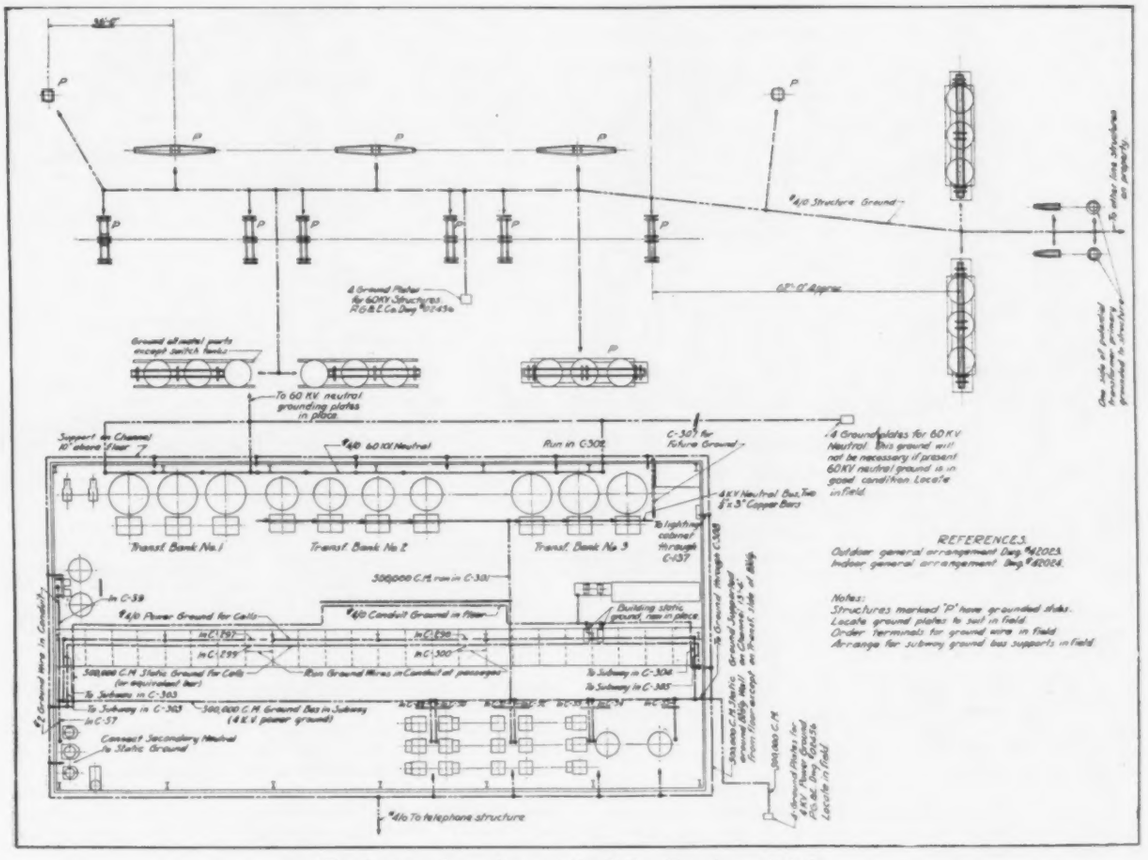

#4/0 Structure Ground
4 Ground Plates for 60KV Structures P.G.&E. Co. Dwg #12456
60'-0" Approx.
Ground all metal parts except switch tanks
To 60 KV neutral grounding plates in place
Support in Channel 10" above Floor
#4/0 60 KV Neutral
Run in C-302
C-303 for Future Ground
4 Ground plates for 60 KV Neutral. This ground will not be necessary if present 60KV neutral ground is in good condition. Locate in field.
4 K.V. Neutral Bus, Two 4"x.3" Copper Bars
To lightning cabinet through C-307
Transf. Bank No. 1
Transf. Bank No. 2
Transf. Bank No. 3
500,000 C.M. run in C-301
In C-59
#4/0 Power Ground for Cells
#4/0 Conduit Ground in Floor
Building static ground, run in place
In C-297
In C-298
In C-299
In C-300
500,000 C.M. Static Ground for Cells (for equipotential bar)
Run Ground Wires in Conduit at passages
To Subway in C-303
To Subway in C-304
To Subway in C-305
To Subway in C-306
To Subway in C-307
500,000 C.M. Ground Bus in Subway (4 K.V. power ground)
In C-57
Connect Secondary Neutral to Static Ground
#4/0 To Telephone structure
REFERENCES.
Outdoor general arrangement Dwg #42023.
Indoor general arrangement Dwg #42024.
Notes:
Structures marked 'P' have grounded tanks.
Locate ground plates to suit in field.
Order terminals for ground wire in field.
Arrange for subway ground bus supports in field.

Fig. 3—Grounding system at South San Francisco substation.

tential transformer secondary neutrals, instrument cases and similar points.

The capacity of the transformers at the above station, including the three banks, is 18,000 kva. total.

Pit River Power House No. 3

Perhaps the outstanding feature of the ground system of Pit River power house No. 3, constructed in 1924-25, is the fact that a single ground loop is employed to which all individual grounds are connected. This loop passes completely around all apparatus to be grounded and terminates in two series of ground plates, each consisting of three copper plates 5 x 10 ft. and fastened together by 500,000 circ. mil bare copper cable soldered into grooves formed on the edge of the plate.

These ground plates are buried approximately 2 ft. below the concrete apron in the tail race and over the center of each individual plate is a 3-in. hole to permit the passage of sufficient water to keep the ground surrounding it always moist.

From each of these series of ground plates two 500,000-circ. mil bare copper cables are laid to the apparatus to be grounded, including the tanks of oil switches and transformers, framework of the building, transformer and generator neutrals, penstocks and instrument cases.

The cable which was used was taken from the high-tension line originally connecting the Hat Creek power house. Due to the capacity of the grounds installed it was thought better to connect everything to them rather than to endeavor to secure separate grounds for the different classes of grounding service.

By installing two complete grounds, one on each end of the loop above mentioned, the chance of a ground failure is rendered almost nil.

Testing Station Grounds

This company has not made a practice of conducting periodic tests of station grounds and it is only in isolated instances that installation tests have been conducted. In October, 1921, tests were carried out to determine the resistance of the two grounds at Claremont substation and for the purpose of making these tests the net work of pipes forming the circulating water system was used as a third ground. By taking a series of readings between each combination of two grounds simultaneous equations were developed and the actual over-all ground resistances, including a certain amount of conductor resistance, were determined.

In these tests all connections were made very close to the substation building and alternating current was used. Current was obtained from the primary side of a current transformer by exciting the secondary side at 110 volts through a small carbon-pile rheostat. Values of current of from 80 to 100 amperes were obtained and the voltage drop across the two grounds was recorded. The resistance of the current-carrying ground was found to be 0.0056 ohm and the resistance of the static ground 0.0092 ohm. Although this seems unusually low, it must be remembered that at this time of the year conditions were very favorable and that both grounds are located in soil which normally is saturated.

Furthermore, there is only a comparatively short distance between the two grounds so that the readings actually are conductor-to-ground resistance (neglecting a very small amount of conductor resistance) and do not include a larger drop which might take place between the two grounds if they were more widely separated.

General

An accident which occurred due to improper grounding on Sept. 14, 1924, at the Livermore substation may be of interest. There was installed at this substation a 60-kv. lightning arrester which was connected to the same ground to which was attached the cases of the transformers in the main booster bank. This ground had been operating satisfactorily without any indication of trouble. At 12:50 p.m. on the above date, however, lightning jumped the 60-kv. horn gaps at this station and instead of finding sufficient capacity in the lightning arrester ground, jumped to the transformer cases and from there to the main neutral ground of the station transformers which was installed within a comparatively short distance of the transformers. In so

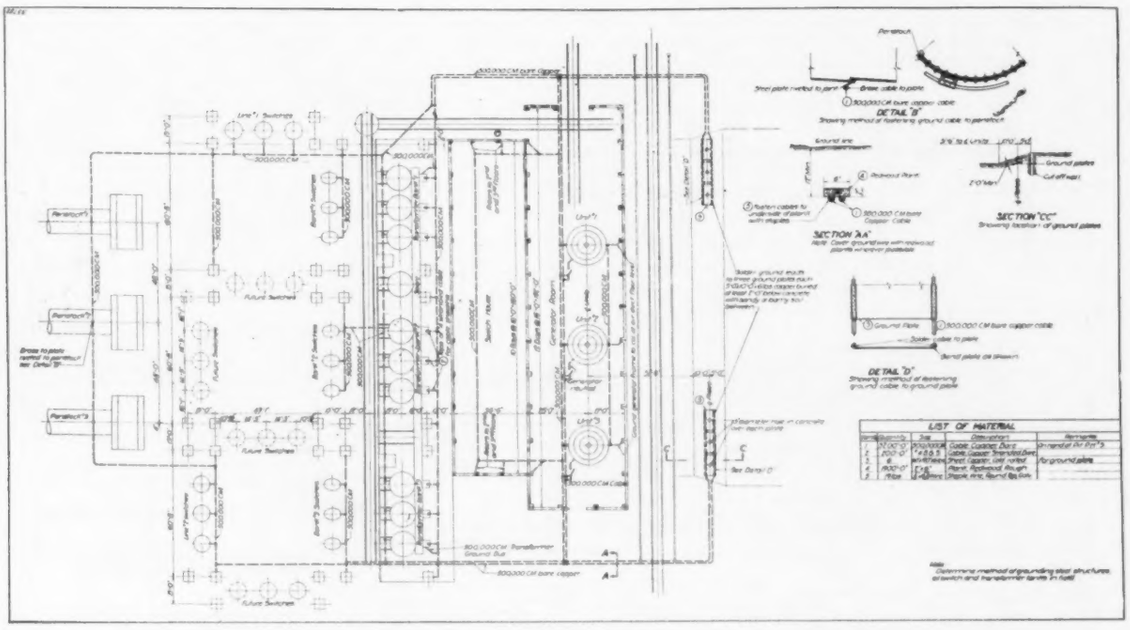


Fig. 4—Arrangement of ground plates and cables at Pit 3 power house.

doing it burned a large hole in the case of one of the transformers, necessitating taking it out of service for repairs. This difficulty could not have happened had the lightning arrester been grounded separately from all other apparatus.

At some of the outlying stations we have experienced difficulty in obtaining proper grounds at or near the station and have been obliged to locate the grounds at some distance, carrying the grounding wires either overhead or under the ground from the station to the point of final grounding. At the Long Point substation two ⅜-in. guy cables are carried 250 ft. from the station to the stream. These cables are buried in the ground and are grounded at the stream to standard cast-iron ground plates. One is used for a power ground and one for a static ground. These circuits were buried principally due to the fact that the station was not intended as a permanent station and no difficulty with rusting of the galvanized cables was expected during the comparatively short period of time it would be in operation.

At Colfax substation there are two No. 3 copper conductors carried overhead for a current-carrying ground and one No. 6 for a static ground. These are carried overhead a distance of 400 or 500 ft. to plate grounds for the power ground and a pipe which is driven for the static ground.

Fire-Fighting Equipment Used by L. A. Bureau of Power and Light

By H. H. COX

FAILURE of oil-filled apparatus on the system of the Los Angeles Bureau of Power and Light during the past year has been confined to oil switches having insufficient interrupting capacity. A rather serious interruption was caused by such a failure splitting a welded seam on an oil-switch tank, scattering oil about the station and causing rather a serious oil fire. This switch had its tank vented to the outside of the station through a 3-in. vent pipe connected to a common header across the three tanks.

The two tanks nearest the vent pipe were bulged seriously but did not rupture. Apparently the venting was insufficient to relieve the pressure in the third tank.

These switches now have been rearranged to have a vent pipe from each tank.

Fire-Fighting Equipment

Fire extinguishers in the stations of this bureau all are of the carbon tetrachloride type. One-quart pump-type, 2½ gal. pump-type and 1-gal. air-pressure types are used. No Foamite equipment is as yet in use in the stations. The local fire department has two Foamite trucks in use and these trucks are rather conveniently located near the largest substations.

In case of a serious oil fire in any of the stations our load dispatcher has instructions to call the fire department and request this apparatus. Cooperation of the fire department in this matter has been assured.

Fire Caused by Failure of Oil-Filled Apparatus

By H. A. LAIDLAW

THERE has been a number of cases of oil-switch failure due to insufficient rupturing capacity of the switch. In some cases the oil has been ignited and has caused considerable damage. One outdoor transformer bank of 750 kva. capacity was completely destroyed by fire due to the oil becoming ignited from an external fire caused by the burning of a small booster transformer, burning oil from which ignited a timber foundation under the larger transformer bank. As a matter of information, this was a temporary installation. The three transformers in the main bank were destroyed completely.

With regard to the equipment for fighting oil fires, this company provides in its various stations sawdust contained in suitable containers, also Pyrene and Babcock extinguishers. Foamite has not been used on this system.

Fire-Fighting Practices of San Joaquin Light & Power Corporation

By J. M. BUSWELL

CARBON-tetrachloride fire extinguishers are used at all stations and substations of the San Joaquin Light & Power Corporation. Two types have been standardized upon:

(1) One-quart, pump-type extinguishers in which the hand pump passes air into the liquid chamber, providing a pressure which ejects the liquid through a nozzle provided with a shut-off valve. This is distinguished from any type from which the liquid is ejected from the extinguisher directly by the pump.

(2) One-gallon extinguishers provided with an interior chamber in which an air pressure of about 100 lb.

is maintained by a self-contained hand pump. On this type of extinguisher there is a gage which shows the pressure in the air chamber, which is shut off by a valve from the liquid chamber, and there is a gage glass on the liquid chamber through which the liquid level may be observed. The liquid chamber can be refilled without exhausting the air because of the fact that the air chamber is shut off from the liquid chamber when the extinguisher is idle.

While it is a fact that carbon tetrachloride thrown onto a hot fire liberates a harmful gas there has been no experience of injury beyond slight soreness of throat in two or three cases.

It is true that the United States Bureau of Standards' specifications should be adhered to in purchasing the carbon tetrachloride for these extinguishers. Monthly inspection is necessary on the one-quart, hand-pump type that they may be kept filled.

Foamite extinguishers are used quite extensively on the system. They are standard equipment for all gasoline, fuel-oil and paint storage and handling risks, and transformer-oil storage or warehouse risks.

These extinguishers have been used upon several occasions and no failures or difficulties have occurred.

Inspection has at times shown the partly clogged condition of the hose and nozzle of a Foamite extinguisher. Realizing that with this type of extinguisher the hose may be left filled with a foam which may dry and obstruct passage the next time the extinguisher is used, a special point is made to keep ever before employees the necessity of thoroughly rinsing this type of extinguisher, including the hose, before recharging. The nozzle as well as the extinguisher in general is inspected each month. If a nozzle shows any signs of obstruction a wire is run completely through the hose and if any substance shows then the extinguisher is removed and attended to, because it is likely that since it was installed or last inspected it has been tipped or shaken.

It also has been noticed that there is on the market at least one brand of recharging material not put up by the manufacturers of the extinguisher, but by some independent concern, the material itself being inferior and causing a caking at the bottom of the extinguisher.

A small supply of this unauthorized material was obtained inadvertently and before discovered by inspection there were complaints to the effect that deterioration of the material itself took place and exploded the cans in the warehouse. Further, there were complaints to the effect that when mixed in the extinguisher and allowed to stand a while cakes formed on the bottom which are liable to break up into scale and clog the extinguisher.

For these reasons all extinguisher materials are purchased strictly on specifications. It is necessary to inspect the supplies received to make sure that they conform to these specifications.

Fire-Fighting Equipment and Experience of the Edison Company

By J. C. GAYLORD, H. L. SAMPSON and L. L. DYER

THE Southern California Edison Company has a committee of four the duty of which is to inspect stations and make recommendations as to what precautions should be taken to prevent fire and also to recommend what fire-fighting equipment should be installed in stations.

This committee has made a great many specific recommendations in regard to stations which existed when the committee began its work and has made general recommendations which, for new work, are being followed now.

(1) For 750 to 3,000-kva., 11/4-2.2-kv. distribution station, without operators:

1 Standard box.
1 Phister extinguisher—1 gal.
1 Phomene extinguisher—2½ gal.
1 Pyrene extinguisher—1 qt.

(This type station consists of an outdoor steel rack for a single 11-kv. line with arresters, a bank of three 250-kva. to three 1,000-kva. outdoor, natural cooled transformers and simple connections, and a 16 x 24-ft. sheet steel building with equipment inside for a maximum of six 2.2-kv. or 4-kv. lines arranged for connection to one or two three-phase induction regulators.)

(2) For 1,500 to 6,000-kva., 11-15/4-2.2-kv. distribution station, with operators:

1 Phister extinguisher—1. gal.
1 Phomene extinguisher—2½ gal.
1 Pyrene extinguisher—1 qt.

(This type of station is similar to the one of smaller capacity noted above except that there are three or four outdoor 11- or 15-kv. switches and each distribution line has its own regulator, so there may be from three to ten regulators.)

(3) For 3,000 to 15,000-kva., 60/15-kv. or 11/4-2.2-kv. transmission and distribution stations, with operators:

1 Oceco engine, 10 gal. capacity.
1 Phister extinguisher—1 gal.
1 Phomene extinguisher—1½ gal.
2 Pyrene extinguishers—1 qt.

(This type of station consists of 60-kv. outdoor steel rack with three or more circuits, a 15-kv. or 11-kv., outdoor steel rack with three or more circuits, and some 4-kv. or 2.2-kv. equipment with three or more circuits.)

Synchronous Condensers and Generators

Condensers of 5,000-kva. capacity or below are not equipped with special arrangements for fighting fire unless they are of the type having closed end-bells and exhaust ducts for the hot air. In such cases means are provided for closing the exhaust ducts and connecting a portable Oceco engine to smother the fire inside the closed system.

Condensers of 10,000-kva. capacity and larger are provided with exhaust-air ducts having dampers for closing the ducts. A 10-gal. Oceco engine is permanently connected through the condenser housing to a pipe ring with non-automatic spray nozzles at each end of the stator winding. A valve is conveniently located outside the condenser housing so that in case of fire the carbon tetrachloride can be turned on by the operator.

Many of the larger generators in the steam and waterpower plants are equipped in a similar manner to that just described for the larger condensers. Some of the steam-driven generators are equipped with live-steam smother systems. In the new steam plant at Long Beach the cooling system for the generators is closed completely and the same air is used over and over again. These generators are equipped so that carbon tetrachloride can be injected into this air in quantities sufficient to insure an atmosphere which will not support combustion.

The high-tension switches in this plant are enclosed each in a separate compartment with fire doors between compartments. These compartments are piped to a central point where a supply of carbon tetrachloride is kept under pressure and so connected with a system of pipes and valves that the operator can turn the liquid into any compartment where a fire exists. Each compartment is equipped with non-automatic spray nozzles to finely vaporize the liquid and direct it at the switch in that compartment.

Cottages, store rooms and other similar buildings are provided with the standard soda-and-acid extinguishers.

Fire-Fighting Experience

There are the following experiences to report in regard to fighting fires in stations:

(1) On March 18, 1923, Newmark station was wrecked by an explosion and resulting fire. It consisted of one large room with ten 60-kv. Kelman indoor breakers, three 15-kv. Kelman indoor breakers and six 1,500-kva. transformers.

The explosion apparently was caused by a breaker failure and was of such violence that it tore the heavy doors from the building and hurled them nearly a hundred feet. The fire which followed was so intense that no attempt was made for some time to extinguish it. It was finally extinguished by about one hour's work with a ¾-in. garden hose.

(2) On Sept. 5, and again on Sept. 18, 1923, 15-kv. breaker failures in Vernon substation filled the bus room with burning oil and developed such severe fires that the whole bus fell from the ceiling. The first fire was extinguished in 15 minutes and the second in 10 minutes with 10 gal. of carbon tetrachloride and 20 gal. of soda-and-acid chemical.

(3) On Feb. 2, 1924, a 30-kv. breaker exploded at Los Angeles substation No. 3, an outdoor station. An oil fire of great violence developed. The use of tetrachloride had practically no effect, but the fire depart-

ment extinguished it within five minutes after its arrival with water.

(4) March 3, 1924, a fire from the failure of a K-12 breaker in Dalton substation was very quickly extinguished with a 2½-gal. Phomene extinguisher, but the station was off the line for 8 hours to clean up and dry out the equipment.

(5) On July 15, 1924, a violent explosion and fire occurred in a 15-kv. switch gallery of the Redondo steam plant. Because of its location, water could not be used. All available chemicals had no effect because it was impossible to get near enough to reach the seat of the fire. It was finally extinguished by a Foamite pumping engine furnished by the Los Angeles fire department. Here also was a very extensive clean-up job after the fire was extinguished.

Conclusions

The following points are the conclusions arrived at in regard to the different methods of extinguishing station fires:

(1) Water is the most effective extinguisher when applied in sufficient quantities, but will do considerable damage itself and make drying out necessary if used on equipment. (2) Foam is very effective, but also leaves equipment in bad shape. (3) Tetrachloride is effective in confined places but is of little use in the open unless used by an experienced person. In any case, tetrachloride gas is dangerous to life, and all station men should be well instructed in its use. (4) Sand or a mixture of Redwood saw-dust and soda can be used very effectively on small oil fires on the floor or ground, but are of little use otherwise.

The experiences previously outlined have led to the adoption of the following practices:

(1) Install all possible equipment out of doors where explosions have a minimum effect and fire can be reached from all sides.

(2) Eliminate all inflammable platforms, walks and other structures which can catch burning oil.

(3) Furnish enough water, and foam equipment to extinguish oil fires on the ground and tetrachloride equipment to smother fires in the switches themselves or in closed compartments.

(4) Foam equipment is used in 2½-, 10-, 20- and 40-gal. sizes. Tetrachloride equipment is used in ¼-, 1-, 10- and 20-gal. sizes.

(5) Cottages, store rooms and similar structures also are provided with the standard soda-and-acid extinguishers.

This report covers in brief the general practice of the Southern California Edison Company in regard to fire-fighting equipment, but does not describe any station in detail. The location of a station and whether or not city fire apparatus is available has a great deal to do with the equipment installed, especially in stations large enough that fire-fighting is given special consideration.

Fire-Fighting Apparatus at Long Beach Steam Plant No. 2

THERE are three forms of fire-fighting systems installed in the Long Beach No. 2 steam plant, none of which are automatic in their application. In the first place a fire-fighting water system has been installed all over the plant with the exception of the switch-house, this being omitted to prevent the use of a conducting liquid on parts which may be alive.

This system uses ocean water, it being the most reliable and easily available supply, taking it from the condenser intake tunnels by means of a pump at one end of the turbine room basement. Eight-inch fire lines lead from this point around the outside of the main building and connect to four risers at symmetrical points, at the ends of the building, leading to hose stations at convenient points on the different floors of the turbine and boiler rooms.

A special steam smother system has been installed to extinguish fires in the fuel oil pump room in the northwest corner of the station and in the fuel oil tanks adjacent, underground outside of the house. Two separate steam lines supply this room, steam being used also to heat the oil and to run the turbine-driven pumps. A 2½-in. line having small holes drilled along its length is placed all around the wall of the room so it can be filled quickly with steam. Pipes also lead to the hot-oil supply tanks and to each compartment of the main tanks. The valves for all of these are located in the hallway just outside the pump room.

For combating electrical fires both the generators and the switch house have been provided with carbon-

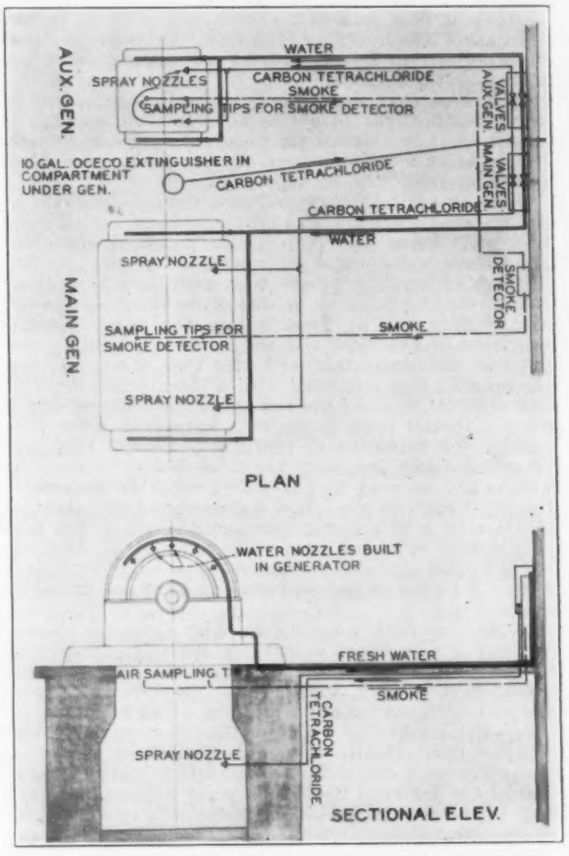


Fig. 1—Plan view and sectional elevation showing schematically the built-in fire fighting system on turbo-generator sets.

tetrachloride extinguishers, there being no other form in the switch house. The generators also have water extinguishers to use in case the others fail.

On the turbine floor near each machine are mounted three boxes, a valve box for the main generator, one for the auxiliary generator and a smoke detector for both. The latter simply is a steel box with tubes leading from the air discharge of each generator. Some of the air is blown into the box and by means of a light any smoke may be seen. This is necessitated by the fact that the generator is entirely enclosed, circulating its cooling air through a chamber containing water-cooled radiators. The air cooling chamber is directly below the generator taking a position similar to the condenser under the turbine. In this chamber the carbon-tetrachloride nozzles are directed into the stream of air entering the generators. As only a small amount of air is in the circulating system it should require only a small amount of extinguisher to smother a fire. Should the extinguisher fail to work, water may be turned on. To reduce the damage to generator this is fresh, not salt water.

In the switch house, carbon-tetrachloride is piped from tanks to each switch cell with valves in the hallway so the liquid may be turned into any cell through a single nozzle near the top of the circuit-breaker tanks. The cells are separate, concrete rooms with metal doors and oil curbs, so any fire can quickly be smothered. The main transformers and the lightning arresters are mounted outdoors and the only other indoor apparatus that may cause a fire are the instrument transformers. These are in cells, but are not provided with extinguishing pipes as the hazard is considered insufficient

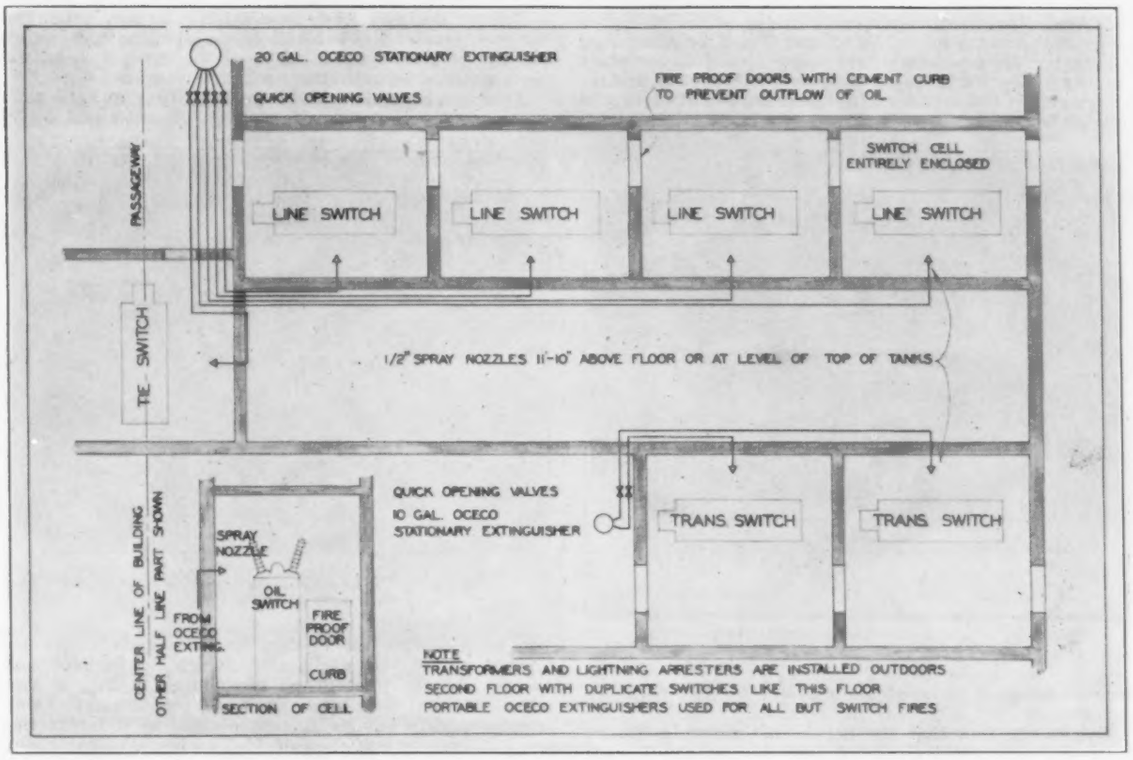

20 GAL. OCECO STATIONARY EXTINGUISHER
QUICK OPENING VALVES
FIRE PROOF DOORS WITH CEMENT CURB TO PREVENT OUTFLOW OF OIL
SWITCH CELL ENTIRELY ENCLOSED
PASSAGEWAY
LINE SWITCH
LINE SWITCH
LINE SWITCH
LINE SWITCH
TIE SWITCH
1/2" SPRAY NOZZLES 11'-10" ABOVE FLOOR OR AT LEVEL OF TOP OF TANKS
QUICK OPENING VALVES
10 GAL. OCECO STATIONARY EXTINGUISHER
TRANS. SWITCH
TRANS. SWITCH
SPRAY NOZZLE
OIL SWITCH
FIRE PROOF DOOR
CURB
FROM OCECO EXTING.
CENTER LINE OF BUILDING
OTHER HALF LIKE PART SHOWN
SECTION OF CELL
NOTE
TRANSFORMERS AND LIGHTNING ARRESTERS ARE INSTALLED OUTDOORS
SECOND FLOOR WITH DUPLICATE SWITCHES LIKE THIS FLOOR
PORTABLE OCECO EXTINGUISHERS USED FOR ALL BUT SWITCH FIRES

Fig. 2.—Diagram showing schematically the arrangement of the built-in fire fighting equipment installed in the new switch house.

to warrant the expense. Portable extinguishers are provided for use here or in the store rooms or switchboard room. A ventilating system is installed in the switch house with ducts to each room and switch cell so any gases generated in a switch will be carried out of the building.

Figures 1 and 2 show diagrammatically the arrangements explained in the foregoing.

Latest Development in Pacific Coast Steam Plant Practice

Report of Prime Movers Bureau, Technical Section*

THE activities of the Prime Movers Bureau for the year 1924-25 have consisted of making studies of mechanical oil burning furnaces and refractories, steam power plant layouts and heat balance. Considerable time has been devoted to round table discussion of various operating troubles on such subjects as condensers and boilers.

Mechanical Oil Burning Furnaces

Practically all the recent developments in mechanical oil burning furnaces on the Pacific Coast have been described in the last report of the subcommittee on the "Burning of Liquid and Gaseous Fuels" of the National Electric Light Association, Serial Report No. 24-86. This subject was assigned to this bureau by the national committee and what additional data was accumulated has been sent to them for their disposal.

The Southern California Edison Company in carrying on its investigation to determine the qualities of the refractories to be used in its new Long Beach steam plant station conducted extensive tests, a modified report of which is included in this report.

Steam Power Plant Layout

A detailed report on the mechanical equipment of the new Long Beach steam plant No. 2 of the Southern California Edison Company is given herewith. This report gives a very good example of the latest equipment for a high-pressure oil-burning steam electric generating plant. The data given for the Los Angeles Gas & Electric Corporation Alameda Street plant shows the equipment installed for one of the latest of the lower pressure oil burning steam electric generating plants on the Pacific Coast.

There are included in the last part of this report a heat balance calculation and diagram for the Long Beach steam plant No. 2 and also curves showing some actual test results.

Fire Brick Tests Long Beach Steam Plant No. 2

After an extensive series of tests of various makes of fire brick at the Massachusetts Institute of Tech-

* C. E. Steinbeck, Pacific Gas and Electric Company, chairman; C. F. Braun, C. F. Braun Company; J. M. Brennan, Pacific Gas and Electric Company; E. L. Champion, Pasadena Light and Power Department; C. H. Delany, Pacific Gas and Electric Company; V. Estcourt, Pacific Gas and Electric Company; G. W. Hamilton, Westinghouse Electric & Manufacturing Company; V. E. Johnson, The Southern Sierras Power Company; L. J. Kraps, Southern California Edison Company; R. F. Leefield, Los Angeles Gas & Electric Corporation; H. S. Markey, Great Western Power Company; A. Y. Meudell, San Joaquin Light & Power Corporation; R. F. Monges, General Electric Company; M. E. Mulkey, Pacific Gas and Electric Company; A. D. Murphy, San Diego Consolidated Gas & Electric Company; G. Z. Ogden, San Joaquin Light & Power Corporation; R. C. Powell, Pacific Gas and Electric Company; E. A. Quinn, San Joaquin Light & Power Corporation; Weller Reed, Los Angeles Gas & Electric Corporation; C. P. Rhine, San Joaquin Light & Power Corporation; P. M. Robinson, Hunt-Mirk Company; J. G. Rollo, Los Angeles Gas & Electric Corporation; Emory Sherwin, San Diego Consolidated Gas & Electric Corporation; C. R. Stewart, Southern California Edison Company; W. E. Thomson, Southern California Edison Company; W. E. Thompson, Southern California Edison Company; E. E. Valk, General Electric Company; R. A. Wallingford, San Joaquin Light & Power Corporation; W. J. Wheeler, San Diego Consolidated Gas & Electric Corporation; C. W. Wiggins, San Diego Consolidated Gas & Electric Corporation; F. V. Wright, The Southern Sierras Power Company.

nology under their direction, the engineers of Stone & Webster, Inc., recommended initially that fire brick hereafter designated as No. 1 and No. 2 be purchased for use in all furnaces of the Long Beach steam plant No. 2; brand No. 2 to be used in the higher temperature parts of the furnace with the exception of the floors for which brand No. 3 was recommended. A later

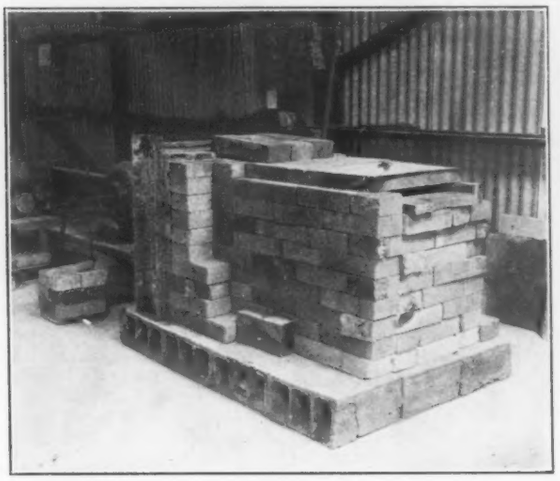


Fig. 1—General arrangement of furnace for spall test.

recommendation included brand No. 1 for two furnaces complete.

Due to the fact that the Southern California Edison Company was not acquainted with two of the brands and that one of them had not been tried out in mechanical fuel oil burning furnaces, company engineers felt that it would be advisable to get a comparison in as short a time as possible between these two brands and brand No. 1. To get this comparison in a short time, it was decided to place brick of each of the three brands and later a brand No. 4 in test furnaces. Various photographs and data which follow show the results of these tests.

Spall Test

Fig. 1 shows the general arrangement of the furnace used for the spall test. Fig. 2 shows the brick as set up in the furnace before firing. Gas and air were forced into the furnace by the blower and burned directly in front of the row of test brick.

At the start with the furnace closed as shown in Fig. 1 the furnace was fired for 20 min., then the gas cut off and the blower allowed to run for 10 min. with one of the top brick of the furnace standing vertically to allow obesrvation of the cooling action on the test brick. During the 20-min. heating period, the brick came up to a bright cherry red temperature estimated at between 2,500 and 2,700 deg. F., and during the cooling period they cooled to considerably below black temperature. Reading from left to right as shown in Fig. 2 the order of the test bricks is as follows: 4, 1, 2 and 3.

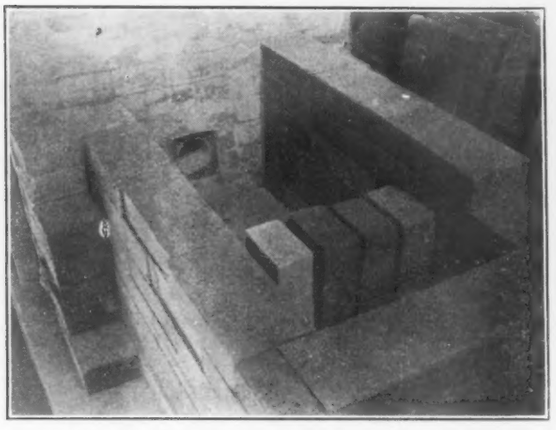


Fig. 2—Bricks as set up in the furnace before firing.

During the first cycle and within 60 sec. after the fire was started brick No. 4 began spalling and before the end of that cycle the side of the brick next to the fire showed a large number of surface cracks.

After eight cycles of 20 min. heating and 10 min. cooling each, the time of heating was changed to 30

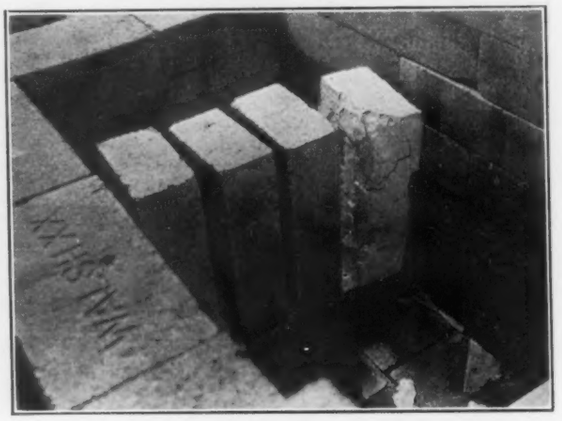


Fig. 3—Condition of bricks after 76th cycle. (Bricks are reversed in order from positions in Fig. 2.)

min. with cooling for 15 min. and this cycle continued through to the 76th cycle, after which the furnace was opened and the photograph reproduced in Fig. 3 was taken. At that time brick No. 4 was considered to be of inferior quality but no difference could be found in the other three. It was then decided to try a more severe heating cycle.

The 77th cycle included heating for 3 hr. until cone No. 26 was flat (3,002 deg. F.) followed by cooling over night. Fig. 4 shows the results. The samples were removed and photographed as shown in Figs. 5 and 6. Reading from left to right are samples 3, 2 and 1.

Break Test

Each test brick was then given what was called a "break test" consisting of supporting the brick with the brand side up (9 x 4½ in. face) on a 7 in. span, thus breaking it by dropping a 4½-lb. weight on it near the

Fig. 4—Showing results after 77th cycle. (Order same as Fig. 3.)

center of the span. For the first blow the weight was dropped 1 in., for the second 2 in., for the third 3 in., etc., until the twentieth blow which was 20 in., the twenty-first 22 in., then the twenty-second 24 in., etc. The weight consisted of a piece of 1 in. round iron bar with a striking surface of approximately ½ sq. in. area slightly rounded. The weight was supported by means of a cord tied to the upper end. It was centered over the brick at the proper height by means of a guide then dropped by releasing the cord or simply quickly lowering the supporting hand. In this manner

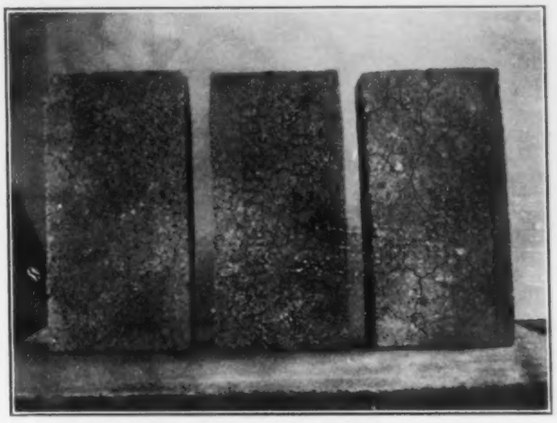


Fig. 5—Face view of bricks 3, 2 and 1 after spall tests.

it was possible to keep the blows within an area of approximately 1½ sq. in. near the center of the span of the brick. The results of the break test are given in Table I and the broken ends of the brick are shown in Fig. 7. From left to right are samples 1, 2 and 3.

Warp Test

One brick of each of the four brands was set up with a 7-in. span as shown in Fig. 8 in a gas fired furnace. This furnace was fired for approximately 48 hr. until cone No. 28 went down and it was estimated that had

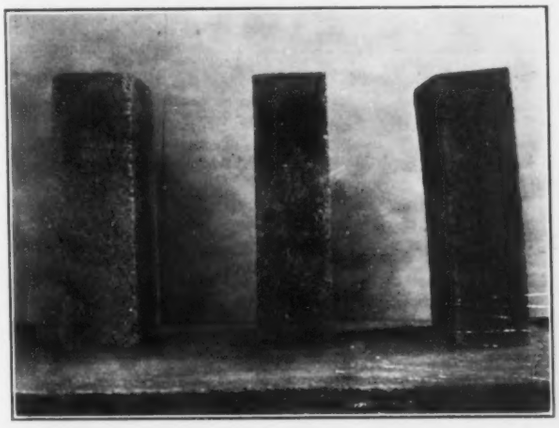


Fig. 6—Side view of bricks after tests. (Same order as Fig. 6.)

cone No. 30 been placed in the furnace, it would have been started, showing the temperature must have been about 3,100 deg. F. Fig. 9 shows the bricks after cooling. Fig. 10 shows the bricks after being subjected to the break test. They appear in the following order, 1, 2 and 3. The data of the "break test" shrinkage and warp are given in the tabulation and indicate apparently less vitrification and slightly more warp on the part of sample No. 1 than the others, but the results are hardly conclusive. Sample No. 4 failed by breaking and showed excessive shrinkage.

Kiln Fire Test

One brick of each brand was set up with the 4½ in. dimension vertical in a fire box of an oil fired kiln with the fire ends of the brick 39 in. from the oil burner. The brick and fire box were literally sprayed with oil for several days during the slow heating of the kiln. Firing continued for 8 days, then while the bricks were still hot the bag wall fell in on the test brick causing considerable deformation of sample No. 4, but

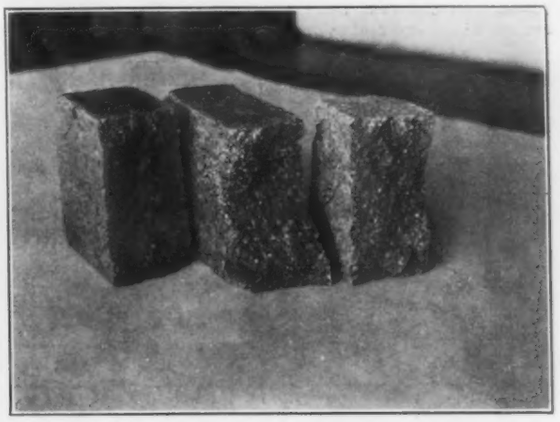


Fig. 7—Condition of bricks after breaking tests.

doing little harm to the other three. All are shown in Fig. 11 in regular order 1, 2, 3 and 4. After bricks 1, 2 and 3 were broken for observation of vitrification photographs reproduced in Fig. 12 were taken to show the texture of the brick. The shrinkage data is given in Table I. In this case sample No. 2 showed considerably less shrinkage than the other two but all were thoroughly vitrified.

Test in Boiler Furnaces of the Pasadena Municipal Steam Plant

One of the bricks of each of the four brands was set in the furnace of boiler No. 10, the base brick in

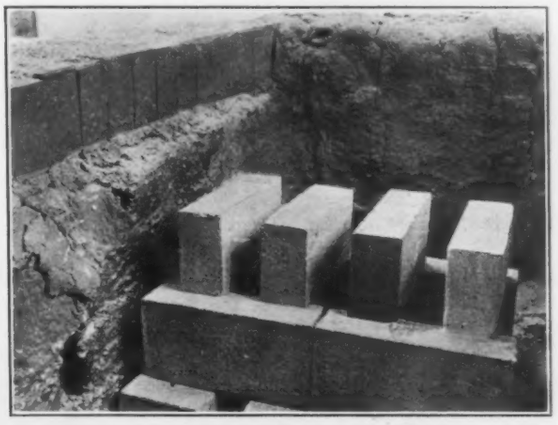


Fig. 8—Bricks set up for warp test.

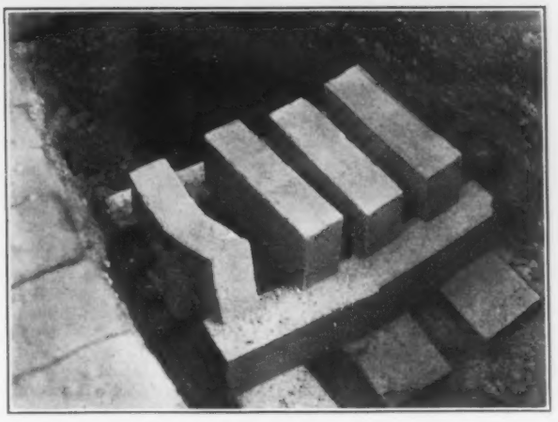


Fig. 9—Condition of bricks after cooling from warp test.

each case being the same as sample No. 1. These were set up 5½ ft. away from and a little below the level of the bottom of the air register of the mechanical oil burner. After 55 days of almost continuous firing of this furnace at 175 per cent rating, the furnace was cooled off and photographs reproduced in Fig. 13 were taken and the test bricks removed. The bricks were arranged in the following order: 4, 1, 2 and 3.

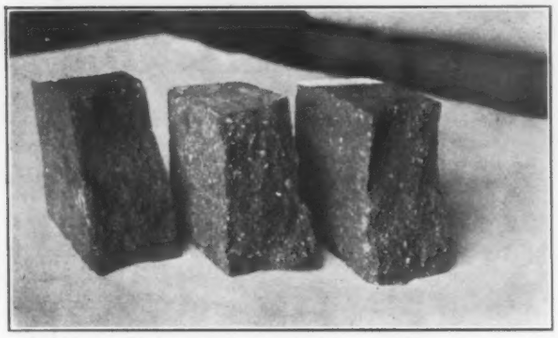


Fig. 10—Condition of bricks from Fig. 9, after being subjected to break test.

An interesting point in connection with this group of bricks was the formation of slag on the top of the bricks. This was attributed to the scale which drops from the boiler tubes on to the top surface of the bricks.

The results of the shrinkage and break tests are given in Table I. Fig. 14 shows the broken ends of these bricks placed in order 1, 2 and 3.

the bricks were removed from the furnace. Sample No. 4 bricks were found to be a mass of small pieces. About half of the top of brick No. 1 was still in place but leaning over. About one-third of sample brick No. 2 and pedestal were still in place. All of sample No. 3 had fallen over.

The bricks were removed from the furnace and measurements made as far as possible. The vitrification of

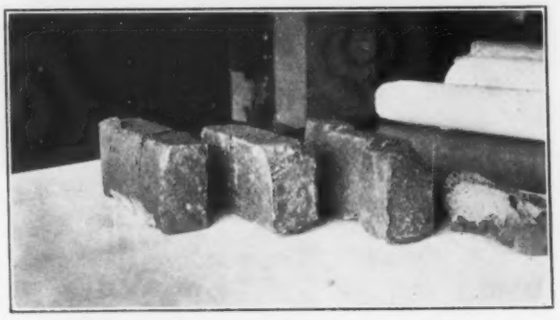


Fig. 11—Condition of bricks after kiln fire test.

samples No. 2 and 3 bricks as shown in Fig. 19 was complete. In the case of sample No. 1 the center three-fourths of the brick was not vitrified. The arrangement as designated in all other photographs, from left to right, is 1, 2 and 3. The shrinkage measurements as given in Table I indicate the shrinkage of sample No. 1 was greater than that of the others but as in other cases it seems unlikely that it should be considered conclusive.

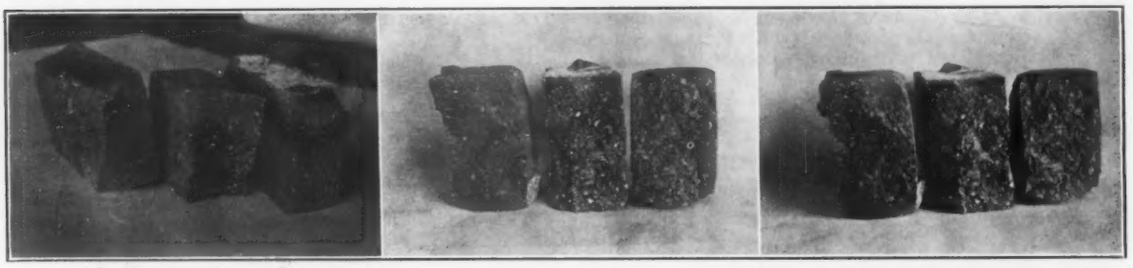


Fig. 12—Bricks 1, 2 and 3 after kiln fire test showing vitrification.

Test in Furnace of San Diego Consolidated Gas & Electric Company

The group of bricks as shown in Fig. 15 were set up in the furnace of boiler No. 23 which is shown in Fig. 16, with the bricks directly in front of but below the second burner from the righthand side in the lower row. The bricks were considerably below the center line of

Fig. 13—Bricks after 55-day test in fire box at Pasadena steam plant.

the burner as shown in Fig. 17, the near end of the bricks being 7½ ft. from the burned wall. The arrangement of the samples as shown in Fig. 15 is 3, 2, 1 and 4.

In each case the two top bricks of the pedestal were of the brand to be tested and in the case of sample No. 4 the three top bricks. The other bricks of the pedestals were of sample No. 1. After 100 days of nearly continuous firing the furnace was cooled down and the photograph reproduced in Fig. 18 was taken before

Station Details Long Beach Steam Plant No. 2

General

Location—Long Beach, Calif., on site of plant No. 1, east end of Terminal Island.

Plot—Approximately 18 acres, El. 14, nearly level.

Service—Base load, power and light, supplementing hydroelectric system.

Capacity—70,000 kw. normal, present and ultimate, in two 35,000-kw. units.

Initial Construction—Jan. 15, 1924.

Initial operation—First unit, Dec. 3, 1924; second unit, about Feb. 15, 1925.

Buildings—Main, including both boiler and turbine rooms, and switch house.

Boiler and turbine room building—Concrete and steel construction—**Boiler room:** main floor, El. 36, 196

x 109 ft.; basement, El. 14.5, 196 x 74 ft.; roof, El. 101. **Turbine room:** main floor, El. 36, 207 x 67 ft.; basement floor, El. 207 x 102 ft.; crane rail, El. 72; roof, El. 91. **Office structure:** three stories, 23x67 ft., in east end of turbine room, El. 36, 47 and 57. **Switch house:** Reinforced concrete construction; ground floor, El. 14.5, 207 x 85 ft.; switchboard floor, El. 36, 207 x 85 ft.; roof, El. 58. **Foundations:** Natural soil with fir piling, reinforced concrete slab.

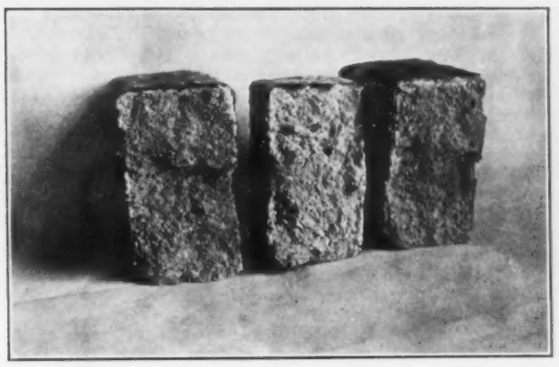


Fig. 14—Broken ends of bricks after test in fire box at Pasadena steam plant.

Main Apparatus

Turbo-generators—General Electric Company, two sets. **Turbine:** Curtis; horizontal, 40,000 kw., continuous with steam at 350 lb. gage, 70 deg. F. (26 deg. F. superheat), and 1.5 in. mercury absolute back pressure; 20-stage, straight line flow with four bleeding points, 1,500 r.p.m.; steam consumption guaranteed no bleeding, 40,000 kw. 10.10 lb. per kw-hr.; 35,000 kw. 10.00 lb. per kw-hr. **Generator, main:** continuous rating unity power factor 40,000 kva.; rating .9 power factor 38,888 kva.; 11 kv., 3 phase, 50 cycle; excitation required, 38,888 kva. .9 power factor, equals 121 kw. **Generator, auxiliary:** continuous rating 4,000 kva. at .7 power factor, 3 phase, 2,300 volts, 50 cycles; excitation required at rating 31.9 kw. with a 45-kw. 250-volt direct-connected exciter. **Complete unit:** 64 ft. 6 in. long, 20 ft. 3 in. wide, 14 ft. 8 in. high; installed weight 900,000 lb.

TABLE I

	Brick Sample No. 1	2	3	4
Test No. 1	10 blows	24 blows	10 blows	.....
Test No. 2	8 blows	11 blows	9 blows	7 blows
Spall test—8 short, 68 medium and 2 long cycles, gas fired				
Break—blows	1	3	3	.....
Shrinkage—length	4.1%	1.0%	2.0%	.....
Shrinkage—Volume	13.1%	2.4%	4.0%	.....
Warp	1/4 in.	1/32 in.	0	.....
Warp test—Set on 7-in. span with 4 1/2-in. dimension vertical; cone No. 28 down; estimated cone No. 30 bent (3,100 deg. F); fired 48 hr. with gas				
Break—blows	18	34	28	.....
Shrinkage—length	0.6%	0.9%	0.9%	11%
Shrinkage—volume	2.4%	2.1%	1.3%	31.2%
Warp—top 9 in.	7/64 in.	5/64 in.	5/64 in.	.....
Warp—bottom 7 in.	9/64 in.	7/64 in.	5/32 in.	.....
Kiln fire test No. 1—Set in kiln fire box through normal kiln firing period 4 1/2-in. dimension vertical, 8 days, oil fired.				
Shrinkage—length	4.3%	1.5%	2.0%	.....
Shrinkage—volume	12.4%	3.3%	9.4%	.....
Furnace test—Set in test furnace; 9-in. dimension vertical; fired 48 hr. with gas; cone No. 30 leaning slightly (3,146 deg. F.); gas fired.				
Break—blows	12	28	16	3
Shrinkage—length	4.7%	1.2%	1.6%	16.6%
Shrinkage—volume	11.8%	3.5%	2.3%	41.3%
Set in fire box; 9-in. dimension vertical; fired 48 hr. with gas.				
Break—blows	7	13	8	.....
Shrinkage—length	1.0%	0	2.5%	1.8%
Shrinkage—volume	3.0%	0	6.1%	8.5%
Pasadena boiler No. 10—Set on furnace floor 5 1/2 ft. from Coen mechanical fuel oil burner; fired 55 days.				
Break—blows	5	5	5	.....
Shrinkage—length	0	0	2.7%	.7
Shrinkage—volume	2.5%	0	6.2%	4.7%
Boiler No. 11—Set on pedestal; 7-in. span with 4 1/2-in. dimension vertical 39-in. from Coen mechanical fuel oil burner; 18 days.				
Shrinkage—length	3.8%	0	2.9%	.....
Shrinkage—volume	11.2%	0	3.2%	.....
San Diego boiler No. 23—Set on pedestals; 4 1/2-in. dimension vertical 7 ft. 6 in. from B&W San Diego mechanical oil burners; fired 100 days.				
Shrinkage—length	11.8%	7.6	7.2	.....
Shrinkage—volume	40.1%	33.7	34.6	.....

Exciter sets (three)—Two 175-kw. dual drive sets, General Electric Company—**Generator:** 175 kw., 250 volt, 2 wire, 6 pole, self-excited, shunt and inter-pole field winding, 1,470 r.p.m. **Motor:** 260 hp., double squirrel cage, constant speed, 2,200 volt. **Turbine:** Curtis impulse, non-condensing, direct-connected. One 350-kw. motor-generator set, General Electric Company—**Generator:** 350 kw., 250 volt, 2 wire, 6 pole, self-excited, shunt and inter-pole field winding, 970 r.p.m. **Motor:** 510 hp., 220 volt, standard squirrel cage, with starting compensator.

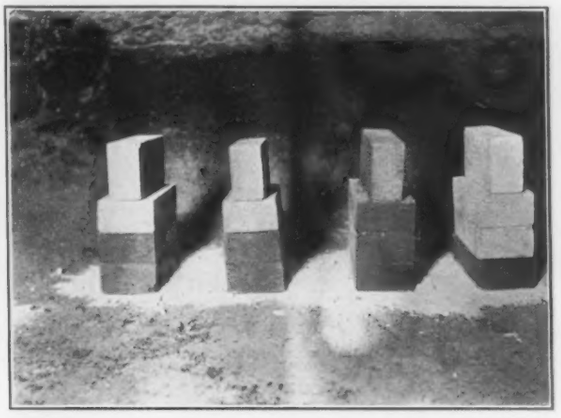


Fig. 15—Bricks arranged for test in fire box of San Diego Consolidated Gas & Electric Company plant.

TABLE II.—Analyses of fire bricks tested

Chemist*	Brick sample No. 1 (a) Per cent	1 (b) Per cent	2 (a) Per cent	2 (b) Per cent	3 (a) Per cent	3 (b) Per cent
SiO_2	56.60	56.20	49.50	47.00	53.04	51.50
Al_2O_3	38.10	39.05	44.98	47.80	41.12	42.85
Fe_2O_3	2.08	2.30	1.28	1.55	1.76	1.80
TiO_2	2.00	1.35	2.48	2.15	2.48	1.85
CaO	.73	.56	.41	.75	.50	.70
MgO	0	.75	0	.35	0	1.25
K_2O—Na_2O	.90	....	1.11	....	1.26	....
Ignition loss	.26	....	0	....	.14	....
Total	100.67	100.21	99.76	99.60	100.30	99.95

*One brick of each brand was analyzed, each chemist taking one-half of each brick.

Transformers—Main power: seven, 13,000 kva., single phase, oil cooled and insulated, 11,000 volt, delta to 72,000 volt Y, outdoor type with 110,000-volt bushings, General Electric Company.

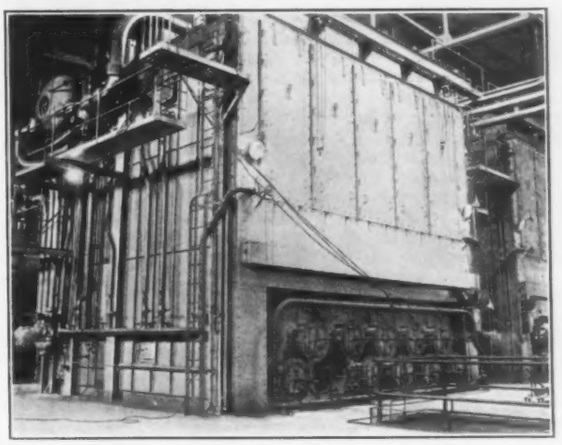


Fig. 16—Boiler in which tests were made by San Diego Consolidated Gas & Electric Company.

Condensers—Two surface type: radial flow, Westinghouse Electric & Manufacturing Company, each with 5,500 sq. ft. of 1-in. outside diameter 20 ft. 3 in. long,

No. 16 B.W.G. cup-drawn Admiralty tubes of Scoville Manufacturing Company, arranged in a cylindrical nest with tubes equally spaced throughout. Shell is shaped so that nearly all of the outer surface of the tube nest is exposed to incoming steam. Air off-take is at center of tube nest. Water boxes are divided and arranged for two-pass operation. Tubes are packed, both ends, with "Dura Metallic" packing and have "Flow Rite"

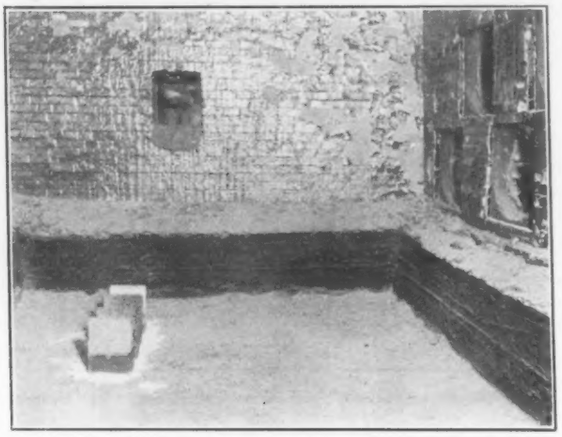


Fig. 17—Location of bricks in boiler shown in Fig. 16.

nozzles in all inlet ends. **Dimensions: Tube sheets**—15 ft. 2 in. diameter by 1½ in. thick; **condenser**—30 ft. 2 in. long, 20 ft. 3 in. wide, 24 ft. 1 in. high, weight, empty (including tubes), 550,000 lb. **Supports:** 24 pairs springs.

Fig. 18—Bricks after 100-day test, before removing from fire box.

Circulating pumps—Two for each condenser, Westinghouse centrifugal; 35,000 g.p.m., 22-ft. head, double runner, double suction, 290 r.p.m., direct-connected to 250-hp., wound rotor, Westinghouse induction motor, with manual speed control.

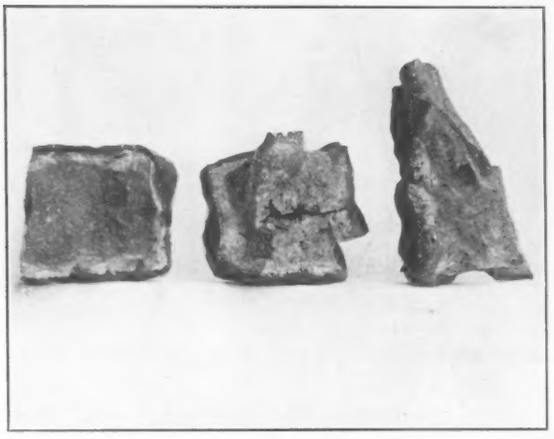


Fig. 19—Showing vitrification after 100-day test.

Condensate pumps—Two Westinghouse pumps for each condenser; 2 stage centrifugal, 1,000 g.p.m., 155-ft. head, direct-connected to 100-hp. Westinghouse induction motor, 960 r.p.m.

Air removal equipment—Two complete Westinghouse units for each condenser; each unit consisting of two 2-stage ejectors with inter and after condenser using condensate and salt water in inter-cooler and condensate in after condenser. **Capacity:** each 2-stage element, 108 lb. per hr. dry air at 28½ in. mercury vacuum, with not over 720 lb. per hr. steam. Performance, guarantee: With 70,000 g.p.m. circulating water at 72 deg. F. will condense 350,000 lb. per hr. steam and maintain vacuuc at 1.39 in. mercury, delivering condensate at temperature same as that of steam entering; condensate at the hot well will not contain over .07 c.c. per leader of free oxygen.

Boilers, superheaters and economizers—Eight water-tube boilers, bent-tube type, each equipped with a superheater located between the first and second bank of tubes and economizer at rear:

Boiler (type)	Stirling	Connelly	
Manufacturer	Babcock & Wilcox Company	D. Connelly Boiler Company and Llewellyn Iron Works	
Number installed	4	4	
Water heating surface (sq. ft.)	14,916	15,000	
Tubes	3¼-in. o. d. No. 8 B.W.G.	3¼-in. o. d. No. 8 B.W.G.	
Mud drums, diameter and plate thickness	48 in.–2.0 in.	48 in.–1.72 in.	
Upper drums, diameter and plate thickness	42 in.–1.81 in.	42 in.–1.51 in.	
Designed for pressure (lb.per sq. in.)	400	400	
Superheater	B&W	Foster	
Type	convection	convection	
Heating surface (sq. ft.)	3,574	5,780	
Pressure drop 250 percent rating lb.	5.1	3.0	
Economizer	B&W steel tube	Foster	
Heating surface (sq. ft.)	11,095	11,448	
Steel tubes—2-in. o. d. No. 6 B.W.G.	plain	with cast iron fins	
Boilers setting—			
Mud drum center line above firing floor	13 ft. 1½ in.	10 ft. 6 in.	
Combustion space (cu. ft.)	6,400	5,600	
Furnace floor area (sq. ft.)	313.6	315.7	
Ratios of heating surfaces—			
Superheater to boiler, percent	24.0	38.5	
Economizer to boiler, percent	74.4	76.3	
Boiler to furnace volume (sq. ft. to cu. ft.)	2.33	2.68	
Furnace volume to boiler hp. 250 percent rating (cu. ft. to boiler hp.)	1.71	1.49	
Fuel	Oil or Gas	Oil	Gas
Boiler efficiency percent	73.5	75.1	73.3
Superheat (deg. F.)	280	268	268
Temperature rise, economizer from 285 deg. F.	112	96	80
Flue gases to stack, deg. F.	455	425	420
Over-all efficiency per cent	82.1	82.2	79.0

Performance—boiler, superheater and economizer at 250 percent rating, 375 lb. per sq. in. gage pressure.

Combustion system—Fuel oil pumps: Four screw type, 65 g.p.m., 250-lb. pressure, William E. Quimby, Inc.; three direct connected to 20-hp., 970 r.p.m. General Electric motors; one direct-connected to Westinghouse steam turbine, 1,300 r.p.m **Fuel oil heaters:** four sets two per set each heater 175 sq. ft. surface of ⅝-in. brass tubes, C. F. Braun Company; each set to heat 65 g.p.m. oil from 90 to 275 deg. F. **Fuel oil strainers:** Simplex, C. F. Braun Company. **Fuel oil tanks:** two service—4,500 bbl., underground, reinforced concrete, with heating coils; two storage—30,000 bbl., steel, above ground, 86 ft. diameter, 30 ft. high, with reinforced concrete dike. **Fuel oil temperature regulators:** four Sarco. **Fuel oil transfer pumps:** one—500 g.p.m., rotary, positive displacement, 100-ft. head, 325 r.p.m., Kinney Manufacturing Company, geared to 20-hp., 960-r.p.m. General Electric motor; one—300 g.p.m., rotary, positive displacement, 100-hp. head, 280 r.p.m., with 20-hp., 960-r.p.m. General Electric motor. **Fuel oil piping:** pump suctions—two 8-in. headers with 4-in. pump connections; discharge—two 6-in. headers between pumps and heaters with 4-in. connections to both; two 6-in. header connections from heaters to main headers. **Main header:** loop, 4-in. with 2-in. branches to boilers. **Return line:** single 4-in. line with 2-in. connection at each boiler; pressure regulator to control header pressure by by-passing from main header to return line. Mason Regulator Company. **Relief valves:** Eight, Crane Company. **Expansion joints:** copper, E. B. Badger & Sons Company; velocity flow in 4-in. header, 96 ft. per min. maximum. **Fuel oil emergency cut-off valves:** arranged to close automatically in case of failure of either forced or induced draft fan; eight—2-in.

Tagliabue Manufacturing Company, diaphragm motor operated, each with one Cutler-Hammer solenoid and one Crane Company solenoid operated control valve. **Gas piping:** A 24-in. main enters the building from the metering station, connecting to loop header of 18, 16, 14 and 12-in. pipes with one 10-in. connection to each boiler; velocity of flow in header 9,000 ft. per min. max. **Gas emergency cut-off valves.** To close automatically on failure of eitiher forced or induced draft fan; eight—10-in. Tagliabue Manufacturing Company diaphragm motor operated, each with one Cutler-Hammer solenoid and one Crane Company solendoid control valve. **Burners:** Stirling boilers—each fifteen B.&W., San Diego type mechanical oil burners, with special impeller plate and gas-burning attachment; Connelly boilers—each, fifteen Peabody mechanical oil burners, with modified orifice ring for burning gas. **Fans:** Forced draft—eight No. 7½ R.B., Green Fuel Economizer Company, 60,000 cu. ft. per min., 2-in. static pressure, direct-connected to General Electric 30-hp., 500-r.p.m., slip-ring motors, with variable speed control operated by push buttons on boiler operating board; induced draft—eight No. 8 RR, Green Fuel Economizer Company, 110,000 cu. ft. per min., 4-in. static (Connelly) and 3-in. static (Stirling) pressure, direct-connected to General Electric 100-hp., 326 to 540-r.p.m., brush-shifting motor, with variable speed control operated from boiler control board. **Boiler furnaces:** ventilated walls—all walls of high-temperature zone are 9 in. thick of high-grade firebrick bonded to steel casing frame, with forced ventilation through air ducts between brick and casing; furnace floors—have forced ventilation also; Stirling furnaces—have brick bonded to frame by means of the B.&W.. method; Connelly furnaces—have brick bonded to frame by means of the Combustion Engineering Company method; firebrick—used for high-temperature zones was approximately as follows: 180,000 A.P. Green Firebrick Company, Mizzou brand; 75,000 Walsh Fire Clay Products Company, XX brand; 86,000 Vitrefrax Company, Argon AA dry pressed brand. **Draft loss:** furnaces to stack, 250 per cent rating—Stirling 1.08 in.; Connelly 3.5 in. water. **Boiler casings:** sheet steel panel construction with 4 in. of heat insulating material between the air ducts and outside sheets; magnesia block insulation was used for Stirling casings and silocel plastic for Connelly boilers. **Stacks:** four—one for each two boilers, superimposed reinforced concrete construction, unlined, built by Webber Chimney Company, 13 ft. 4 in. inside diameter at top, 73 ft. 8 in. high, set on concrete matt on building structural steel with top of stacks 126 ft. above furnace floor.

Steam piping system—High-pressure steam: (375 lb., 700 deg. F.), main and auxiliary headers, main branches and boiler blow-off; extra strong lap-welded steel pipe, cast steel fittings, with Sargol joints. **Main steam header and turbine branches:** 18 in. outside diameter by ⅝ in. thick, and boiler branches, 10 in. diameter by ½ in. thick, Pittsburgh Valve Foundry & Construction Company; main headers 147 ft. long, anchored at turbine, branch connections with 27-ft. high expansion bend at center; pipe bends on 7-ft. 6-in. radius. **Auxiliary steam piping:** M. K. Mitchell & Company. **Boiler blow-off piping:** Grinnell Company. **Valves:** cast steel, Monel trim, main header and branches—three 18-in., eight 10-in., gate valves, Pittsburgh Valve, Foundry & Construction Company; boiler non-return—four 10-in., eight 8-in., Schutte & Koerting Company; auxiliary steam lines—gate, Crane Company, globe, Edward Valve & Manufacturing Company; reducing and regulating valves—steam, Fisher Governor Company and Mason Regulator Company; relief valves—175-lb. auxiliary steam lines, Consolidated Safety Valve Company. **Miscellaneous:** Motor operating equipment—for eleven main steam valves, Payne Dean, Ltd.; drip system—Holly, Russell B. Hobson; high-pressure traps—two C. E. Squires Company; pipe covering—all 700 deg. F. steam pipes have inner covering of diatomaceous earth, magnesia and asbestos fiber, with outer covering of 85 per cent magnesia; other steam and hot water piping covered with 85 per cent magnesia; all covering is of Johns-Manville manufacture applied by the Asbestos Manufacturing Company of California. **Velocity of flow:** high-pressure steam—boiler outlets, 8,700 ft. per min., maximum; main header, 11,700 ft. per min., maximum, 8,800 ft. per min. normal.

Boiler feed water system—Feed pumps: Four 5-stage, 1,000 g.p.m., Jeansville double suction, centrifugal, made by Worthington Pump & Machinery Corporation for 440-lb. discharge head with 150-lb. pressure on suction, three direct-connected to General Electric 250-hp., 1,460-r.p.m. slip-ring motors, one direct-connected to Westinghouse steam turbine, 1,570 r.p.m. with variable speed governor. **Booster pumps:** Four 2-stage, single suction, 1,000 g.p.m., centrifugal, Byron Jackson Pump Manufacturing Company, direct-connected to 100-hp., 1,450-r.p.m., constant-speed, General Electric motors. **Feed pump regulators:** Each motor-driven pump has a 3-step manual variable speed control with automatic speed control of four steps for each step of manual, automatic control by means of Ruggles Clingman regulator; the turbine-driven pump is equipped with Fisher Governor Company pressure regulator. **Boiler feed regulators:** Sixteen sets controllers, Williams Gage Company, two on each boiler, 3-in. **Feed water heaters:** Two sets, five heaters in each set made by Griscom Russell Company, each set—one 18th-stage heater, 4-pass, with 1,950 sq. ft. Muntz tubes; one 18th-stage heat exchanger, "Multiwhirl," with 67.5 sq. ft. Muntz tubes; one 11th-stage heater, 4-pass, with 2,090 sq. ft. of Admiralty tubes; one 11th-stage heat exchanger, single-pass, with 350 sq. ft. Muntz tubes; one Gland steam condenser, 6-pass, with 735 sq. ft. Muntz tubes. **Evaporators:** Two sets, Bethlehem Shipbuilding Corporation, double effect, submerged-tube type, each set—two Bethlehem-Weir vertical, low-pressure, single-effect evaporators, each with 450 sq. ft. surface of coiled copper tubes; one evaporator condenser, 2-pass, with 650 sq. ft. straight copper tubes; one evaporator preheater, single-pass, with 50 sq. ft. of straight copper tubes; one blow-off pump, Hytor, Nash Engineering Company, direct-connected to ½-hp. motor; performance—each set to produce 17,500 lb. per hr. of distilled water with not over 1 grain per gal. total solids from raw water containing about 25 grains per gal. total solids, steam supply to be from 15th stage of turbine, 12,970 lb. per hr. at 19.5-lb. absolute pressure. **Deaerators:** Two Cochrane Corporation, reboiling type, each—one vertical open heater, 9 ft. 3 in. diameter by 10 ft. high inside, with heating and deaerating trays; one vent condenser, 3-pass, with 430 sq. ft. straight tubes; one vacuum pump, Hytor, Nash Engineering Company, direct-connected to motor; performance—each deterator to reduce the oxygen content of 400,000 lb. feed water per hr. to .03 c.c. per leader when supplied with 14,430 lb. steam per hr. from the 15th-stage bleeding point. **Tanks for feed water:** One 68,000-gal. distilled water tank, reinforced concrete, under boiler-room basement; two 6,000-gal. steel surge tanks on boiler-room roof. **Tanks for raw water:** Two 6,000-gal. reinforced concrete in bases of stacks; two 2,000 gal., steel bearing cooling reserve supply; one 36-ft. diameter by 110 ft. high, steel standpipe 750,000-gal. capacity (storage for both No. 1 and No. 2 plants); well water pumps—to raise well water from standpipe to 6,000 and 2,000-gal. tanks in top of boiler room, float-controlled: two 2-stage centrifugal, 500 g.p.m., 160-ft. discharge head, Pacific Pump Works, direct-connected to 30-hp., 1,450-r.p.m General Electric motors. **Piping:** Feed water, 10-in. line from pumps to two mains and one auxiliary 8-in. header, 4-in. branches to economizers and two 3-in. lines between economizers and boilers, extra strong lap-welded Grinnell Company. **Valves: Low-pressure steam**—steam to evaporators: twelve hydraulic cylinder operated 14-in. Pittsburgh Valve, Foundry & Construction Company; steam to 18th-stage heaters: two 20-in. Pittsburgh Valve, Foundry & Construction with Payne Dean motor operation; steam to 11th-stage heaters; balance to check valve, two 8-in. Atwood & Morrill; **High-pressure steam**—gate, globe and check, Crane Company, cast steel hard metal trim. **Expansion joints:** Copper, E. B. Badger & Sons Company. **Velocity of flow:** 623 ft. per min., maximum. **Miscellaneous pumps:** Two emergency distilled water pumps, single stage, double suction, centrifugal, 9,000 g.p.m., 100-ft. discharge head, Byron Jackson Pump Manufacturing Company, direct-connected to 40-hp., 1,440 r.p.m., constant speed, General Electric motors, service, raise water from distilled water storage tanks under boiler room to surge tanks on roof, float control; four evaporator drip pumps, 2-stage, centrifugal, 75 g.p.m., 147-ft. discharge head, Byron Jackson Pump Manufacturing Company, direct-connected to 10-hp., 1,440-r.p.m General Electric motors; four 18th-stage heater drip pumps, 2-stage, centrifugal, 75 g.p.m., 147-ft. discharge head, Byron Jackson Pump Manufacturing

Company, direct-connected to 10-hp., 1,440-r.p.m. General Electric motors.

Cooling System—Cooling water is taken from a ship channel, conducted to and from the plant through reinforced concrete tunnels. **Head works:** reinforced concrete on piling. **Settling basin:** 110 ft. across, mouth converging to the screens 72 ft. from the mouth, with wall dividing the basin in the center, weir is at El.—5.5, across the mouth; screens—bar grizzlies across mouth; four 10 ft. wide traveling screens at tunnel end of settling basin, Chain Belt Company; gate wells and gates provided for stopping the flow to either half of settling basin or any of the tunnels. **Tunnels: intake**—three 7 ft. sq. by 950 ft. long with bottom at El.—13 connect the headworks to the manifold located between the old and new plants; intake under plant—two 7 ft. sq., narrowing to 3 ft. wide, approximately 224 ft. long with bottom at El.—14; **discharge under plant**—approximately 185 ft. total length of 7 ft. 6 in. high by 3 ft. to 5 ft. wide, reinforced concrete with bottom at El.—5.5, located just over the intake tunnel; **discharge outside of plant**—discharge tunnels from both ends of the building unite near the center of the south building line in one 10-ft. diameter main discharge tunnel with bottom at El.—11, length 542 ft. to the outlet structure. **Outlet structure:** reinforced concrete in piling 58 ft. long, 16 ft. wide with tunnel extending into the outer end, bottom of structure El.—15, bottom of tunnel El.—11, top of end structure El. 6, water outlet weirs El. 1; four horizontal 6x6 ft. outlet openings are provided in the top of the structure, provided with sheet-steel doors. **Manifold:** gate and access wells for each of the three main and one auxiliary intake tunnels; gate, access and stationary screen wells for two tunnels into No. 2 plant and one tunnel into No. 1 plant; pump and piping for unwatering of any of the seven connecting tunnels. **Water velocities:** in tunnels outside of buildings—195 ft. per min. maximum in intake; 250 ft. per min. maximum in discharge; condenser tubes 215 ft. per min. or 3.58 ft. per sec., maximum.

Condenser cooling system—Piping: 42 in. cast iron, two lines to and from each condenser. **Valves:** eight 42 in. Pittsburgh Valve, Foundry & Construction Company, with Payne Dean motor-operating equipment. **Expansion joints:** rubber, U. S. Rubber Company. **Pumps:** See condenser.

Generator cooling system—Main and auxiliary generator closed circuit air circulating through fin-type, tubular coolers with salt cooling water. **Air coolers:** General Electric Company. **Pumps:** two, single stage, centrifugal, 1,500 g.p.m., 65-ft. head, DeLaval Steam Turbine Company, direct-connected to 40-hp., 1,450-r.p.m. General Electric motors. **Piping:** 8-in. cast iron lines, interconnected with low service pumps and reserve tanks. **Strainers:** four 10 in., C. F. Braun Company, single basket.

Transformer cooling system—Oil circulated through coolers with salt cooling water, one oil cooler and one oil pump for each transformer. **Oil coolers:** seven 2-pass,"Multiwhirl" vertical, Griscom Russell Company, 131 sq. ft. of ⅝-in. tubes. **Pumps: oil circulating**—seven 100 g.p.m., 67-ft. head, single stage centrifugal De Laval Steam Turbine Company, direct-connected to 5-hp., 1,450-r.p.m. General Electric motors; **salt cooling water**—one single stage centrifugal, 1,500 g.p.m., 65-ft. head, De Laval Steam Turbine Company, direct-connected to 40-hp., 1,450-r.p.m. General Electric motors. **Piping:** 8-in. cast iron lines interconnected with low service salt water pumps and reserve tanks. **Strainers:** two 10 in., Andale Engineering Company, single basket. **Low service pumps:** two 1,500 g.p.m., 125-ft. head, single stage centrifugal, De Laval Steam Turbine Company, direct-connected to 100-hp., 1,450-r.p.m. General Electric motors; **piping**—8 in. cast iron connecting to headers of air-cooling and transformer-cooliing systems; **strainers**—four, Andale Engineering Company, single basket. **Reserve tanks:** salt water—two, 6,000-gal. reinforced concrete tanks in stack bases (low service pumps are controlled automatically from the level of water in these tanks). **Regulating valves**: two 8 in., Kieley & Mueller. **Turbine lubricating oil cooler:** two for each unit, Andale Engineering Company. Air ejector intercoolers and turbine lubricating oil coolers take salt water from the low service lines. Bearing cooling water is drawn from the two 2,000-gal. steel fresh water tanks under roof of boiler room.

Miscellaneous Equipment

Lubricating oil purifying and handling equipment—Purifiers: two continuous by-pass filters, S. F. Bowser & Company; one centrifugal purified, De Laval Separator Company. **Pumps:** one 100 g.p.m., 50-ft. head, rotary, Blackmer Rotary Pump Company, geared to 5-hp. General Electric motor.

Priming system—Pumps: two, Hytor, Nash Engineering Company. Steam jets: two, Schutte & Koerting.

Sump pumps—Building drains: two vertical 300 g.p.m., 3 in., 20-ft. head, Worthington Pump & Machinery Corporation, direct-connected to 5-hp., 960-r.p.m. General Electric motors. **Atmospheric relief and back pressure valves:** two 36 in., and four 12 in., Atwood & Morrill Company.

Ventilating fans—Switch house: three 7,500 cu. ft. per min., one 10,000 cu. ft. per min., Green Fuel Economizer Company, direct-connected to General Electric motor.

Transformer oil filters—Two 30 g.p.m, 12 in., and one 10 g.p.m., 7 in., General Electric Company.

Condenser electrolytic protection—Kirkaldy system: Two sets, 32 electrodes each, with one switchboard, Kirkaldy Engineering Corporation; two motor-generator sets, 1kw., 4-volt, d.c. generator with exciter, both direct-connected to General Electric motor.

Air compressor—One 17 x 10 x 14-ft., 2-stage, 500 to 600 cu. ft. per min., 100-lb. pressure compressor, Ingersoll-Rand Company, belted to 150-hp. General Electric motor.

Crane—Overhead traveling in turbine room: One Shaw crane 100-ton main hoist, 15-ton auxiliary, 4 electric motors, 64-ft. 9½-in. span, Manning, Maxwell & Moore.

Fire-fighting equipment—Fire pump: One 2,000 g.p.m., 206-ft. dicharge head, single-stage centrifugal, De Laval Steam Turbine Company, direct-connected to 175-hp., 1,450 r.pm. General Electric motor. **Fire pipe lines:** 10 in. cast iron pump suction and discharge with two 12-in. Andale Engineering Company strainers in suctions; 8-in. cast iron line around building; four risers in the main building are equipped with valves and hose racks at the various floor levels; five Corey fire hydrants are located about the station yard. **General fire protection:** Each main and auxiliary generator is equipped with tetrachloride and fresh water sprays in the end housings, one 10-gal. carbon tetrachloride extinguisher being provided for the generators of each unit. **Switch house fire protection:** Two 20-gal. carbon tetrachloride extinguishers are installed in the switch house with an outlet nozzle in each circuit breaker room controlled from the main switchboard room, portable 1-gal. extinguishers also are available; **stationary extinguishers**—Oil Conservation Engineering Company; **portable extinguishers**—Phister Manufacturing Company.

Elevator—One combination freight and passenger 4,000-lb. capacity, 85-ft. lift, push-button control, electrical operation, Otis Elevator Company.

Signal system—An illuminated signal pedestal is provided for each turbine in both the turbine and boiler rooms, controlled from the main control switchboard; telephones are provided at each unit.

Metering and Test Equipment

Indicating pressure gages—Ashcroft Manufacturing Company and Foxboro Company.

Master steam gage—30 in., Ashton Valve Company.

Indicating thermometers—Taylor Instrument Companies; **Dial type,** The Foxboro Company.

Vacuum gages—Mercury column, Taylor Instrument Companies.

Recording pressure and vacuum gages—The Foxboro Company.

Recording thermometers—The Foxboro Company.

Recording liquid level gages—The Bristol Company.

Boiler control meters—One on each boiler; record and integrate steam flow; record gas flow through boiler and flue gas temperatures leaving boiler and economizer, Bailey Meter Company.

Boiler control gage—Multipointer, certical scale, Bailey Meter Company, one on each boiler, indicates: air pressure at forced-draft fan, burners; draft—over

fire, at boiler exit, at economizer exit; gas pressure at burners; fuel oil pressure at burners; temperature of feed water leaving economizers.

CO_2 recorder—One on each boiler, Mono, duplex, CO_2 and CO meters, C. J. Tagliabue Manufacturing Company.

Fuel oil meters—Two 4-in. and one 3-in. Bassler, American Liquid Meter Company.

Natural gas meters—Two 10 x 5-in. Venturi tubes, one for each test boiler, with one manometer, Builders Iron Foundry.

Fuel oil tank gaging equipment—One gage connected to two storage tanks, Pneumercator Company.

Boiler feed meters—Two 10 x 5-in. Venturi tube meters in feed pump discharge lines, with indicating, recording and integrating mechanism, Builders Iron Foundry.

Steam flow meters—Stationary electric type, indicating, recording, integrating; two 18-in. steam to turbines; two 8-in. steam to auxiliary header, General Electric Company. **Portable:** indicating type; one 2-in. steam flow to air ejectors, General Electric Company.

Water flow meters—Indicating, recording, integrating, electrical type: two 8-in. in condensate lines, General Electric Company. **Indicating, recording:** Four 42-in. in circulating water lines to condensers, H. S. B. W. Cochrane Corporation. **Integrating disk type:** two 2-in. 125-g.p.m. water to evaporators, Trident, Neptune Meter Company.

Oil flow meters—Indicating: Seven on transformer oil, General Electric flow nozzle, Builders Iron Foundry manometers.

Salinometer—Condensate lines: One 2-point recorder, Leeds & Northrup Company.

Watchman's clock system—Newman, 30 station.

Smoke detectors—for generators, Walter Kidde & Company.

Load and demand indicators—two double-faced Westinghouse Electric & Manufacturing Company.

Test scales—For condensates: two 20-ton tank, Howe Scale Company. **For fuel oil:** one 4-ton tank, Fairbanks-Morse & Company.

Meter and gage boards—Bangor, Pa. Slate, Los Angeles Marble & Tile Company.

Station Details Alameda Street Plant

The following data are submitted in reference to the latest turbines installed in the Alameda Street plant of the Los Angeles Gas & Electric Corporation:

Power Station Arrangement

Turbine and generator—Type: Curtis turbine, General Electric Company. **Steam pressure:** 200-lb. gage. **Temperature:** 488 deg. F. **Bleeder points:** Steam being bled from the 3rd stage at present, 4th stage bleeder to be installed. **Capacity:** 17,500 kw. at .8 power factor. **Water rate:**

Lb. steam per kw-hr.	Kw. load
14.85	7,500
13.85	11,250
13.90	15,000
14.20	17,500

These figures for 200-lb. gage pressure, 100 deg. superheat and maximum back pressure of 3 in. absolute in exhaust chamber of turbine; speed: 1,800 r.p.m., 60 cycles; voltage: 2,400; **Began service:** Aug. 12, 1924.

Condenser—Type: Cylindrical, surface condenser, Wheeler Condenser & Engineering Company. **Cooling surface:** 40,000 sq. ft., 4-pass. **Tube material:** 1 in. outside diam. No. 18 B.W.G. seamless drawn copper, 16 ft. long; approximately 10,000 tubes. **Tube arrangement:** Multipitch plan. **Packing:** John Crane metallic. **Cooling water:** 40,000 g.p.m. at 80 deg. F. to maintain 28.12 in. vacuum when condensing 225,000 lb. steam per hr.; water is in circulation over cooling tower and makeup is of Zeolite-treated water. **Pressure drop:** Through the condenser including gate valves and expension joint is 15 lb. per sq. in.

Condenser air removal equipment—Type: One size G, 2-stage, steam-jet air pump, Wheeler Condenser & Engineering Company. **Position:** air pipes leave condenser about 30 in. below center line of water box. **Steam consumption:** 2,400 lb. steam per hr. required for air removal.

Condensate pumping equipment—Type: Two 5-in., bronze-fitted, double-suction, horizontally split casing type centrifugal pumps, Wheeler Condenser & Engineering Company. **Pumping head:** 111 ft.

Turbine oil-cooling and purifying equipment—Type of oil-cooler: vertical, Schutte & Koerting. **Cooling surface:** 370.5 sq. ft. **Cooling water:** taken from cooling tower pond. **Tube material:** ½-in. brass tubes in cooler. **Type of oil purifier:** Richardson Phoenix filter.

Turbine air washing or cooling equipment—No air washing equipment installed.

Exciters—Type: Direct-connected to turbo-generator shaft, General Electric Company. **Capacity:** 135 kw., 125 volt.

Circulating water pumps—Dual drive, Wheeler Condenser & Engineering Company, direct-connected to 800-hp. General Electric induction motor and 800-hp. Terry turbine through a De Laval reduction gear; constant speed is maintained. **Capacity:** 40,000 g.p.m. at 50-ft. head.

Instruments (steam plant only)—Bristol strip-chart instruments are used for all purposes where recording instruments are used for recording steam temperature; recording vacuum gage; recording thermometers on circulating water inlet and outlet. Ashcroft gages on circulating water line and condensate lines. Tagliabue mercurial thermometers are used for temperature of bearing oil and to check recording thermometers.

Boilers and superheaters—Type: Stirling boilers and B.&W. superheaters, Babcock & Wilcox Company; boilers are of the integral-economized type. **Heating surface:** 8,900 sq. ft., pressure 250-lb. gage. Superheater B.&W.: 254 tubes, plugs are used. **Economizers:** wrought steel, integral with the boiler and contain 2,403 sq. ft. of heating surface; the pressure through the dry pipe is approximately 5 lb. at 200 per cent rating.

Furnace and burners—Burners are of the San Diego type, Babcock & Wilcox Company; 6 burners to the surface. **Furnace volume:** 2,600 cu. ft., brick. McClintisk and A. P. Green. **Side walls:** 22 in. thick. **Front walls:** 9 in. thick to a point 7 ft. 6½ in. above the floor and 18 in. thick above that point. **Rear walls:** 13 in. thick. red brick. (Boilers are in batteries of two, center wall is common to two boilers and is 36 in. thick.) Walls are unventilated and the floors have a 6-ft. space between the foundation, which is solid, and the furnace bottom. (This space is arranged so that the air will circulate under the furnace floor, up the boiler front, into the furnace.) **Draft:** Natural. Burners are located in the lower section of the boiler front and in two rows of three burners each.

Stack—200 ft. high from boiler room floor; 102-in. dia., made of boiler plate, no lining. Stack supported by triple set of guy lines, quartering on stack.

Fuel equipment—Pumps: Three 10 x 7 x 10-in. Blake Knowles, vertical duplex piston pumps, type LO, 300-lb. oil pressure. **Heaters:** 295 sq. ft. Griscom Russell. **Storage and service tanks: two storage**—One 30,000 bbl., the other 50,000 bbl.; **service: five**—combined capacity 26,000 bbl. No combustion control installed.

Feed water equipment—Pumps: De Laval centrifugal 3-stage, 650 g.p.m. **Heaters:** Open type, 325,000 lb. of water per hr., Elliott Company. The makeup water is evaporated and is supplied from the city service mains, first being put through a Permutit softening plant. **Reserve capacity:** 80,000 gal. Wheeler evaporators and Elliott deaerators are used.

Instruments, boiler room—Tag-Mono duplex recorders on flue gas analysis; Republic flow meter to measure water to each boiler; Bristol strip-chart instruments for recording steam pressure, feed-water pressure, steam temperature in header and oil pressure and temperature; General Electric recording watthour meter for turbine; Esterline-Angus recording concentration instruments.

Piping layout—The velocity of the steam from the header to the turbine is approximately 11,000 ft. per min. in a 14-in. line. The header expansion bends are complete circles the radius being 6 ft., 8 in., the ends being offset to make the header line up. Two bends with a radius of 10 ft. each are located in the supply line to the turbine to provide flexibility. The valves on the steam headers are hand-operated gate valves. The valves on the circulating water lines are hydraulically operated and remote-controlled. The water for operating them is taken from the boiler feed lines.

Signal system—Turbine and engine room: The signal system is of the annunciator type. Annunciators are installed in the boiler and turbine rooms and the operators' gallery. Whistles are installed which call to the

annunciator, three blasts for individuals and two for machine operation.

The following is submitted by the apparatus bureau as a report on steam plant layout and pertains to the Alameda Street station of the Los Angeles Gas & Electric Corporation.

Main generators—Three 17,500-kw., one 10,000-kw., one 6,000-kw. and one 4,000-kw. generators, all 2.4-kv., 3-phase units; cooled by air circulated from fans directly mounted on shafts; excitation supplied from

TABLE III

Assumed data

Steam pressure	365 lb. absolute
Steam temperature	700 deg. F.
Extraction at stages	11, 15, 18
Evaporators	
Make up supply percent of steam and condenser	5
Operation—double effect	
Temperature of make-up water	62 deg. F.
Vacuum	28.5 in.
Total load including load on main generator, house generator and house generator exciter	39,200 kw.

Computed data

Item	Steam Lb.	Lb. per hr.	Pressure Lb. absolute	Temp. Deg. F.	B. t. u. per lb.
Steam to main header		432,567	365.0	700	1,358.0
Subtract steam for air ejectors	1,440		175.0		
Steam to turbine throttle		431,127	365.0	700	1,358.0
Steam to gland leak-off	5,370		14.7	638	1,350.0
Steam bled at 11th stage	35,266		81.3	429.6	1,243.0
Steam bled at 15th stage					
Evaporators	11,890		19.6	227	1,143.0
Deaerator	15,511		19.6	227	1,143.0
Steam bled at 18th stage	18,250		3.64	149.1	1,056.8
Total steam bled (20.03 percent)	86,387				
Steam to condenser		344,740	.738	91.9	984.1
	Condensate				
From steam in condenser		344,740	91.9		59.9
Add condensate from inter cooler		360	141.0		109.0
Total from condensate pump		345,100	92.0		60.0
Leaving 18th stage heater		345,100	143.1		111.0
Leaving 18th stage heat exchanger		345,100	144.5		112.4
Add 18th stage drips					
From gland steam desuperheater	1,080				
From 18th stage steam	18,250				
From gland steam	5,370				
From condensate from after condenser	1,080				
Total		25,780	149.1		117.0
To evaporator condenser		370,880	144.8		112.7
Leaving evaporator condenser		370,880	171.4		139.3
Add evaporator drips composed as follows:					
Steam to evaporators at 19.6 lb.		11,890	227.0		1,143.0
Raw water fed		18,100	62.0		30.0
Less evaporator blow off		863	172.0		140.0
Total evaporator drips to system		29,127	177.4		145.3
To inter cooler		400,007	172.4		140.3
From inter cooler		400,007	175.4		143.5
Deduct condensate used to desuperheat gland steam which is returned to system with 18th stage drips		1,080	175.4		143.5
To gland steam condenser		398,927	175.4		143.5
Leaving gland steam condenser		398,927	190.5		158.4
To deaerator		398,927	190.5		158.4
Add steam to deaerator		15,511	227.0		1,143.0
Leaving deaerator		414,438	227.0		195.2
Condensate leaving deaerator		414,438	227.0		195.2
Add drips from 11th stage heat exchanger composed as follows:					
Condensate used to desuperheat 11th stage steam		1,900	234.0		202.5
Eleventh stage extraction steam		35,366	429.6		1,243.0
Total 11th stage drips to system		37,266	234.0		202.2
Condensate to 11th stage heat exchanger		451,704	227.6		195.8
Condensate from 11th stage heat exchanger		451,704	234.2		202.5
Deduct condensate used to desuperheat 11th stage steam which is returned to system with 11th stage drips		1,900	234.2		202.5
Condensate to 11th stage heater		449,804	234.2		202.5
Condensate from 11th stage heater		449,804	307.0		276.8
Condensate to economizers*		449,804	307.0		276.8
Condensate to each economizer†		112,451	307.0		276.8
Condensate from each economizer†		112,451	381.0		355.0

*The quantities to each economizer, and temperatures leaving would depend on the rating at which the boilers were operated.

†This is assuming four boilers on this load.

125-volt, direct-connected exciters, floating on a common bus in parallel with 125-volt, 175-amp.-hr. battery; system operated underground at present; generator leads are made up of flat bus mounted on insulators and carried in separate concrete compartments, excepting one machine which has six 1,500,000-circ. mil lead-covered cables in parallel, pulled through fiber ducts; machine temperature is taken every half hour from coils imbedded in winding; only means of fighting fire is by portable equipment and dampers in air shaft.

Station light and power—Taken from main bus, excepting emergency light and excitation which is taken from 125-volt, 175-amp.hr. battery.

Switchboard and instruments—Panel boards with horizontal, edgewise instruments are arranged in six groups: machines, exciters, tie lines, 15-kv. lines, 2.4-kv. feeders and 500-volt feeders; located on second floor in building across the street from main generating sta-

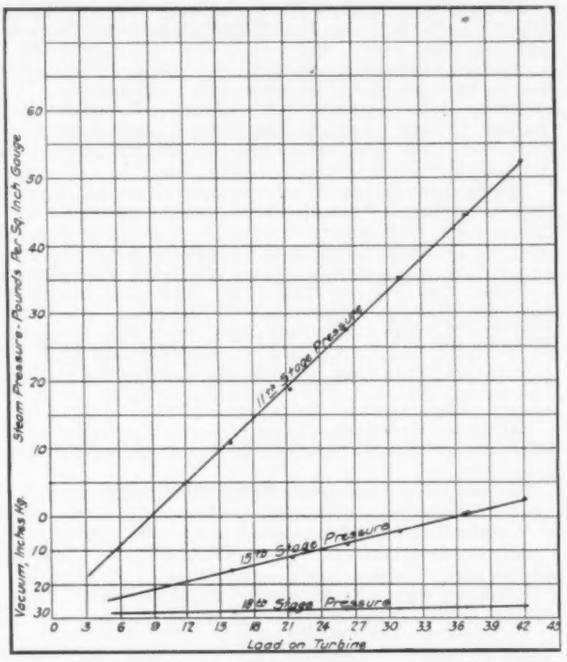


Fig. 21—Stage pressure of turbine No. 8, Long Beach steam plant No. 2, when extracting.

tion; intercommunication accomplished by a 50-phone automatic telephone system, and by an annunciator system that is visible in every department of the plant and can be operated from a number of stations, conveniently located; attention is called to annunciator by steam whistle.

Transformers—Four banks: oil-filled, water-cooled, consisting of two banks 20,000-kva. and two banks 10,000-kva. General Electric transformers; 2.4 kv. low

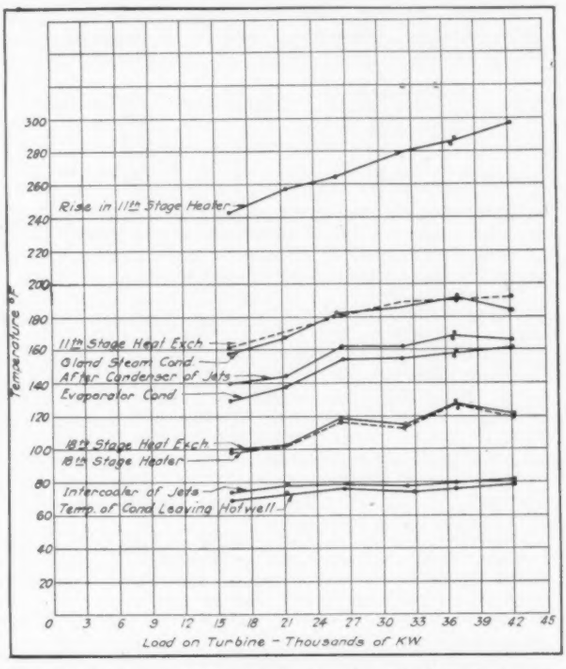


Fig. 22—Condensate temperatures throughout feed water heating system, turbine No. 8, Long Beach steam plant No. 2.

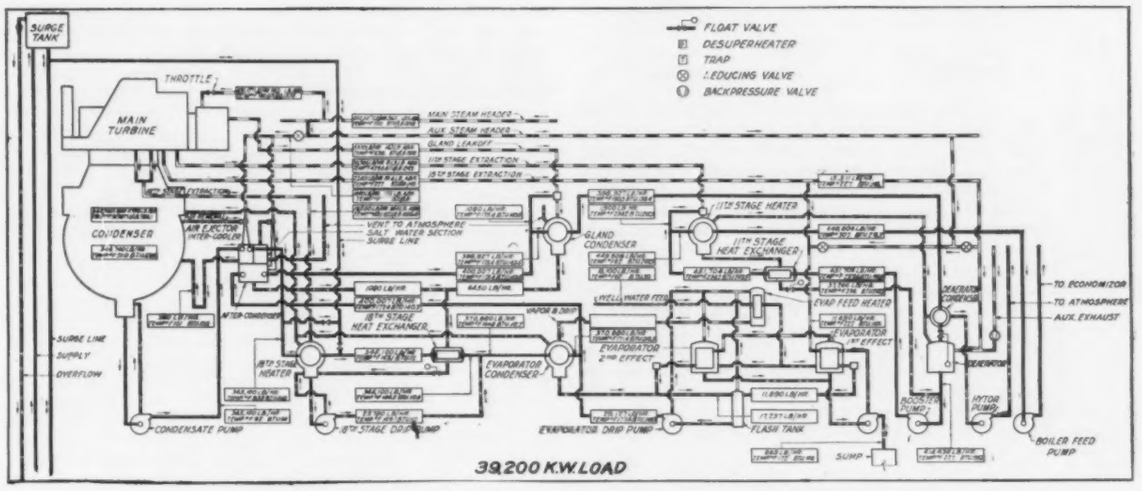


Fig. 20—Heat balance diagram for Long Beach steam plant No. 2.

side, 32.7 kv. high side, operating at present at 16.35 kv., connected delta on the high and low sides. The 20,000-kva. banks are each operated as a unit with a 17,500-kw. turbine; 10,000-kva. banks are used as transfer between high and low buses. All transformers and regulators get their cooling water direct from the discharge of turbine circulating pumps, water being supplied through check valves from each pump. They can also be supplied from city water.

Generator switches—General Electric type, FH-206 oil circuit breakers: Located in switch house same distance from generator, mounted in concrete switch cells; ordinary type of disconnecting switches are mounted directly beneath oil circuit breakers in concrete compartments, buses are the same.

High-voltage switches—General Electric type, FH-209 oil circuit breakers: Installed in the same way as the generator oil circuit breaker; same installation for disconnects.

Feeder equipment—All feeders fed from a double bus, through oil circuit breakers and disconnecting switches, then through 3-phase feeder voltage regulators, to a 3-conductor lead cable which leads to underground system. Oil circuit breakers, disconnecting switches and buses are installed in concrete compartments on second floor of switch house. Regulators are located on first floor of same building, and the underground system comes in the basement.

Protection—For generators: Definite time overload relays and differentially connected relays. **For transformers:** differentially connected relays; high lines by induction over-current relays; feeders by inverse time relays and a system of sectionalizing reactors. **For outgoing high lines:** Oxide film lightning arresters installed on each of the outgoing high lines and one on the 2.4-kv. bus.

Heat Balance

The following data in Table III, submitted by L. J. Kraps of the Southern California Edison Company, gives the calculated heat balance for one of the 40,000-kw., 20-stage Curtis horizontal turbines of the new Long Beach steam plant No. 2.

Fig. 20 shows the above data in the form of a heat balance diagram. Figs. 21 and 22 show actual stage pressures and condensate temperatures for various loads as obtained by test on No. 8 unit at the Long Beach plant No. 2.

Direct-Mail Advertising

By J. CHARLES JORDAN

EFFECTIVE advertising long ago has been outlined as follows: It must be seen; it must be read; it must be believed; and it must cause the reader to want the thing advertised. In in the olden days when communities were small and the territory sparsely settled sales were made mostly by personal contact. Such contacts were limited by the salesman's knowledge of the community and his own reputation. With the influx of population and the growth of industries new methods of selling became necessary, and one of the greatest aids is that of direct-mail advertising. This type of advertising has the advantage of being private. You can reach one or thousands at one time. It also has an important place in any business which seeks to build up and retain the good will of its customers. That it is a powerful adjunct to any business regardless of its preferred methods of advertising is indicated by the spectacular growth of this type of advertising during the past few years.

The public utilities continue to find greater need for personal contact and will continue to use more extensively direct-mail advertising. Sales departments of the utilities maintain selling lists of prospects for various classes of service rendered and for appliances best fitted to the needs of the prospects. Departments of public relations maintain lists in order to keep citizens personally informed of the activities within their various communities. Financial departments of the utilities through letters, magazines and other direct-mail mediums keep the stockholders advised of the company's development and its financial standing. In the building of good will and better public relations direct-mail advertising furnishes a medium through which the utilities can contact with each of their consumers served. It is manifestly impossible for the executives of the public service companies to meet all of the company's customers in person. This, however, can be done through the mails. Just as satisfied customers make a business grow, so does efficient direct-mail contact aid in confidence building that makes satisfied customers.

Publicity and Its Code of Ethics

By Al. C. JOY
Chairman News and Advertising Section

AS the result of effort started shortly prior to the Pacific Coast Electrical Association's convention of 1924, the past year's work of the Publicity Section has been devoted to intensive and cooperative study of publicity and advertising questions. Previously under the label of publicity committee it had been hazy as to its position in the Association. Even its older members had not been clear as to its functions, the committee regarding itself as a publicity body for the Association rather than as a body of representatives of Association units called together to give each other the benefit of experience which might be carried into every-day work. With a new understanding of its purposes, the committee occupied its two half-day sessions at the 1924 convention with carefully prepared papers on publicity and advertising topics, all of which brought forth much profitable discussion.

More important, however, was the determination at this convention to reorganize as a News and Advertising Section, with a definite organizational setup and a different program of work. Our place in the industry is established; it is important. Our group is composed of trained men who obviously should profit as greatly by the exchange of ideas and the joint consideration of problems as any other group in the Association.

Raising of Publicity Standards

In submitting this report of the past year's activities the chairman of the section believes that much good has been accomplished under our new working methods. There has resulted a more sincere and thorough study of publicity and advertising methods and values; an exchange of opinions and experiences by which all members have benefited; and the translation into concrete form of a code of ethics, which previously had existed only as the standards of individual workers.

Obviously publicity men must come into constant contact with the press. They must have knowledge of what the press wants, what it will publish, and why it will publish it. They must have a distinct understanding of the fine differences between publicity and propaganda and of the differences between news and advertising. In the establishment, thefore, of a code of ethics it has been the thought of the section not only to establish better standards for itself and a higher respect among ourselves for the particular work in which we are engaged, but a better understanding of and a higher respect for ourselves among the newspaper men who are our most important contact.

Three Working Bureaus Formed

Two meetings of the section have been held up to the time of the preparation of this report, with another one in prospect prior to the convention.

Preceding the first meeting the chairman had appeared before the executive committee to request that henceforth we should be known as the News and Advertising Section. This request was granted. At the first meeting held on Nov. 21, 1924, in San Francisco, the new name was adopted and a plan of organization agreed upon.

The bureau of technique has had under its consideration the study of advertising, illustrations, moving pictures, news articles and their values, and internal publications and house organs.

The better business bureau has had as its main purposes the consideration of cooperative methods of publicizing and advertising, the establishment of ethical standards under which publicity and advertising work shall be conducted, and the safeguarding of stockholders of utilities from fraudulent promotion schemes. In this latter connection we have sought to keep in touch with the better business bureaus of the Associated Advertising Clubs of the World, supporting the advertising clubs' principle of truth in advertising and striving to protect stockholders from attempts to trade them promotion stocks in questionable enterprises for their valuable public-utility securities. Each department of our own better business bureau's activities has been in charge of a separate committee.

The committee on cooperative methods has given its time chiefly to the problems of the manufacturers and dealers in the electrical appliances.

Under the officers and an executive committee there was set up a bureau of technique, a better business bureau, and an information bureau, each with its separate chairman. The chairmen of these bureaus and one section member chosen at large were with the section chairman, vice-chairman and secretary constituted the executive committee. Members of the various bureaus were chosen because of their particular interest in certain lines of work. Bureaus have held meetings at the call of their own chairmen, and the chairmen in turn have reported activities to the executive committee. The personnel under this organization plan is as follows:

OFFICERS

Al. C. Joy, chairman — C. H. Peirson, vice-chairman
F. S. Myrtle, secretary
Additional members executive committee:
B. S. Allen — J. F. Pollard — G. C. Tenney — A. M. Frost

BUREAU OF TECHNIQUE

B. S. Allen, chairman

Newspaper Advertising
S. W. Green

Direct by Mail Advertising
J. C. Jordan

Illustrations and Moving Pictures
G. C. Tenney

News
C. H. Peirson

Internal Publications
F. S. Myrtle

BETTER BUSINESS BUREAU

J. F. Pollard, chairman

Cooperative Methods

M. W. Scanlon — J. C. Hobrecht — J. C. Jordan — A. H. Nicoll
A. G. Jones — R. H. Weisbrod — V. W. Hartley — J. U. Berry

Standards

F. Z. Stone — R. E. Smith — Carl Burgess
A. E. Holloway — D. L. Scott

INFORMATION BUREAU

G. C. Tenney, chairman
All members of the Section.

Code of Ethics Established

The committee on standards, following the example of a similar committee of the Public Utility Advertising Association, affiliated with the Associated Advertising Clubs of the World, has prepared a code of ethics which was unanimously adopted at the Publicity Section's meeting on Jan. 31. This code of ethics is as follows:

Our obligations and responsibilities being those of the expositor and interpreter of facts, full understanding of which by the public should benefit the public, the publisher acting as intermediary, and the industry:

We pledge ourselves to consider paramount the interest of the public, which in the larger sense includes that of the industry.

To promise rather less than more than the performance will justify.

To make clean statements only, clear, direct and fair alike to customers and competitors.

To establish confidence, through every contact, by deserving confidence.

To buy advertising service on the basis of established, tangible values only.

To furnish to publishers, by request or arrangement, authoritative information concerning the industry and its activities.

Value of Advertising Media

Much of the discussion at the section meetings was concerned with the value of different types of advertising media. Heads of advertising departments are continually solicited to take space in publications of little or no value whatever to the advertiser, the taking of such space being liittle more than a contribution and frequently making such inroads on the budget as to handicap legitimate advertising effort. Consensus of opinion was that advertising, as far as periodicals are concerned, should be confined as nearly as possible to legitimate newspapers and to their regular editions only. So-called special editions, issued on any pretext and often with no apparent excuse, are usually mere money-making schemes and serve no legitimate advertising purpose.

On recommendation of the committee on standards the following resolution was adopted:

"Resolved, That member companies as a general policy do not patronize advertising schemes, programs, etc.

"That, as a matter of general policy, no exploitation editions of newspapers or periodicals be patronized.

"That other special editions be avoided excepting as their advertising value is demonstrated."

It is realized by the Publicity and Advertising Section that hard and fast rules governing such matters cannot be made in the face of long established custom. On the other hand, recognizing the waste of time, effort, and money going into certain types of advertising, the handicap which such advertising presents to our own efforts, and the duty devolving upon us to see that our appropriations are wisely spent, we believe this resolution marks a step in the right direction and that in the course of time all excepting legitimate forms of advertising will be eliminated.

Statistics to Be Assembled

In our plan of organization we have laid the foundation for an information bureau. Here it is proposed that statistics concerning member companies and the industry in general shall be assembled, together with reports on advertising and publicity effort, photographs, etc. Our thanks are due the Journal of Electricity for offering to act as the central agency of this bureau. All information is to be carefully filed, indexed, and made readily accessible to all members of the Association.

Discussions at our meetings have been informal, but have served as the basis for certain papers being prepared by members of this section for publication in the Journal of Electricity's pre-convention issue.

The section has presented to the executive committee of the Pacific Coast Electrical Association and to the National Electric Light Association an offer of all possible assistance in the publicity work of the forthcoming national convention. It has also discussed with Frederick S. Myrtle, chairman of the national convention's publicity committee, ways and means of assisting in his work, and the members of his special committee have been chosen from the ranks of this section.

It is the hope of this section that closer contact may be established with the Public Utilities Advertising Association of the Associated Advertising Clubs of the World. The organization is to conduct one of the important departments at the Advertising Clubs convention at Houston, Texas, in May. The appropriation allocated by the Pacific Coast Electrical Association to this section provides for the section's chairman to attend this convention.

Comparative Values of Advertising and Publicity

By FREDERICK S. MYRTLE

IN a paper presented to the Publicity Section at Coronado last year I discussed at some length the much discussed problem of newspaper advertising for the electrical industry, treating that problem from the standpoint of the public utility, only, as it presents a point of view entirely different from that of the manufacturer or dealer. I assumed then, as now, that the electrical public utility under discussion was not engaged in the business of merchandising appliances, so that the real question to be decided concerned the advisability, not to say necessity, of an advertising appropriation for a public utility having little else than service to advertise.

I maintained at that time, and I think the members of the section agreed with me, that the purpose of public utility advertising is to get people to think about the public utility and think rightly, so that, being interested, they may be informed, and being informed, may judge fairly and correctly when called upon to decide some political or economic problem in which the public utility is vitally concerned. Public utility advertising, therefore, is largely educational. It has been called institutional. It directs the attention of the public to the many problems which the public utility is called upon to solve in order to give the best possible service to its consumers at the most reasonable price to allow a fair return upon its investment. The scope of that field is not small. It may include anything and everything that concerns the operation of a public utility in its relation to the public it serves. It may deal with the physical problems of construction as well as of operation; it may take the readers of its advertisements upon an illustrated tour of the company's properties; it may call striking attention to improvements and betterments of service for the benefit of a particular community where increasing population and agricultural or industrial activity threaten to tax the utility beyond its present available resources for the supply of the commodity needed; it may seek to establish relations of intimacy with the consuming public through the personality of local managers and others engaged in representing the utility in its contact with that public. This last has been called personnel advertising.

In all of these classes of advertising it is next to impossible to measure results with accuracy. They are an "intangible something," so to speak. Nevertheless in the general analysis the public utility has been brought to realize that such advertising is profitable. I desire to repeat here what I said upon this point last year, namely: "It is a good deal like a patient ordered to follo wa vegetable diet. It is impossible for either him or his doctor to measure in drams or scruples, in heart action or blood pressure, the exact percentage of benefit to his system derived from the assimilation of any particular item on his dietetic schedule. Yet by his general improvement the patient is made to know that he is being benefited by the course of treatment."

It is a significant fact that even monopolies have found it worth while to enter the advertising field. The telephone company is a notable example. It is felt that the public has a right to know all it wants to know about the public utility whose service it purchases; what it consists of, how it is run, tracing back, if need be, that service to the point of origin and following its course, step by step, to the point of distribution. Any thinking man will realize that if the public once can be induced to take an interest in the inner workings of any public utility operating in its midst an important poinnt is scored for the utility. It is safe to say that nearly one hundred per cent of the misunderstandings that arise from time to time between the public utility and the public are due to sheer ignorance on the part of the public of what is involved in the services for which the public pays.

The point is made, then, that in this twentieth century age of progress and development the advisability of a public utility entering the advertising field cannot be questioned. There is always question, however, as to what particular form of advertising secures the best results. In an attempt to solve this question I shall suggest that the form of advertising which appeals most to the public and, therefore, should be calculated to insure the best results, is that through which the public utility aims to take the public to its heart, into its confidence. The average reader likes this form of address. He does not care to be bombarded with either statements or statistics; he likes to be led rather than driven; his general attitude, due largely to a time-old distrust of the public service, is inclined to be Missourian; but, as a rule, he is willing to be shown if first he can be made to believe that his confidence, and not his credulity, is sought to be engaged.

The particular public utility with which I have the honor to be associated has conducted a diversified advertising campaign for a number of years and, as far as we are able to judge, with excellent results. Newspapers have been practically the sole advertising medium, but the advertising has been divided into classes according to the purpose sought to be accomplished, a series of educational or institutional advertisements being followed by a series intended to increase sales of the commodities manufactured and distributed by the utility. Our advertising department reports favorable reaction from its campaigns generally, so that it is not easy to pick out any particular kind of advertisement as possessing more popular appeal than another. However, it is the opinion of the department that there are three types of advertisement that appear to elicit the most favorable comment. These are:

First, advertisements which call public attention to local conditions through local mediums of advertising, showing progress and development and the activities prosecuted by the utility in keeping pace with and encouraging such progress and development by specific extensions and improvements of service.

Second, those advertisements which explain, as simply and as lucidly as possible, the intelligent use of the particular commodity for sale; in other words, telling the consumer how to help himself through that intelligent use. The main idea in this form of advertisement is to convince the public that economical use of a commodity brings satisfaction to the consumer, and it is better to have satisfied consumers than extravagant bills for consumption.

Third, the personnel advertisement. Under this head our company instituted a scheme of advertising whereby it introduced to its consumers in various sections of the territory covered by its operations a few of the local men of the company whose business it was to serve them in various capacities. In so doing our company endeavored to bring the point of contact closer, to establish as far as possible a get-together spirit between the public utility and the residents of each community covered by its operations. This class of advertising awakened considerable public interest in the various territorial divisions of the company's operating field.

Not all the utilities, however, resort to newspaper advertising. Some affect billboards; others believe in circularization as having a more direct appeal to the consumer. Slides in motion picture theaters, placards in company offices, and a dozen other methods of stimulating public interest present themselves from time to time.

One particular form of advertising has not been included in those so far discussed for the reason that, unlike the others, it has a direct selling interest and its results are susceptible of more or less accurate measurement. I refer to what is called financial advertising, that is to say, advertising undertaken in connection with a stock or bond-selling campaign. It is known generally that, following the precedent established nearly eleven years ago on the Pacific Coast, most of the utilities now are selling stock over the counter to stockholders, consumers, employees and the general public. In connection with a campaign of that sort it is needless to say that a liberal yet discriminating use of printer's ink is almost indispensable to success.

One of the most desirable things in financial advertising, and one of the most difficult, is the ability to strike a happy medium between advertising designed primarily to attract the eye of the reader and those bristling with financial statistics. The advertiser in this respect must adapt himself to some extent to the character of the medium which he intends to utilize. An advertisement in the "Commercial and Financial Chronicle" or "Wall Street Journal," for example, which circulate almost exclusively among men with more or less financial experience, may be expected to contain little but short statements of fact and pertinent statistics without any "window dressing." On the other hand, advertisements designed for insertion in newspapers having a general circulation should not be overburdened with detailed earnings statements, balance sheets, or other matters of a technical nature.

Following are some of the things concerning which the prospective investor may naturally be assumed to desire information before purchasing a security:

The business in which the company is engaged.
Its growth over a period of years, as reflected by the increase in customers, volume of sales, etc.
The character of the territory in which the company operates, as indicating the possibilities of future development.
The company's past and present earning capacity.
Its present financial position as indicated by the excess of current assets over current liabilities, and particularly its cash working capital.
The property values which its securities represent.
The market for the security and its acceptability by banks as collateral for loans.
The price of the security and the terms upon which it may be purchased.
The rate of dividends and dates of payments.

There are, of course, a good many other points which may suggest themselves. The foregoing are merely some of fundamentals, and advertisements can be designed with advantage to cover, either in a single display or a series of insertions, all of these features.

It must be recognized that a very considerable number of people are not trained sufficiently in financial matters to pick the essential facts out of an earnings statement or to dissect a balance sheet, and the appeal to this class of readers perhaps can be based largely on generalities. Some companies, for example, have secured a considerable measure of success through advertisements emphasizing the value of thrift and the advantages of steady saving, or stressing particularly the unusual degree of safety afforded by public utility investments. As a rule, however, it may be said that generalities, however attractively presented, are not what is desired by the experienced investor. He wants actual facts about the security.

On the general subject of financial advertising it may be stated that a successful campaign for the direct sale of securities involves:

(1) The preparation of advertisements designed to convey in a convincing and easily understandable manner the merits of the issue offered.

(2) An intelligent selection of the most appropriate mediums for the insertion of the various types of advertisements which may be utilized.

So much for newspaper advertising as a means of direct publicity. Wiith that goes what may be called indirect publicity, a most desirable supplement to the other and possessing the added merit of insertion without cost. Newspapers are always willing to print items possessing legitimate news value, such as recent statements of earnings, stories of business development, articles on construction activities, and the like, and the public utilities through this means may secure much valuable publicity which is of interest not only to holders and prospective purchasers of their securities, but also to the general public as consumers. The fact that the newspapers have come to regard the major operations of public utilities as having a definite news value is evidenced by the tremendous increase in recent years in the volume of news publicity as measured by column inches of printed matter.

House Organs—Internal and External

By W. A. CYR

LIKE some specious prescriptions of "rubbing alcohol," house publications of public service companies are used externally as well as internally. Therefore, like Julius Caesar's Gaul, so-called, internal publications may be divided into two varieties—internal and external. A sort of hybrid of the two forms a third.

Internal Publication

Since charity and house organs begin at home, the primary house organ is for strictly Narcissine use, to hold a mirror up to its own face. In other words, the purely internal type is to sell the company to its human components.

No company organization is so united, despite the best internal relations, that no need exists for better knowledge of the company by all of its many individual members. Old timers may be wholly and blindly loyal to a company that for years has treated them fairly; but no company is standing still. It needs new blood as it needs new poles, lines, and meters to augment growing service. And these recruits, coming from the nowhere into the here, must be given in as short time as possible, the ideals, the respect for, and the desire to be loyal to the company that grows into old-timers from long association.

The internal publication, edited in simple and human fashion, seeks to accomplish this task, carrying the ideals of management in understandable terms to the lowliest mucker or ditch digger. In turn it acts as emissary to the management for the man who sets meters or pulls cable, telling his ideals and aspirations, his loyalty and painstaking service.

These strictly internal publications, with circulation limited to the employees themselves, are divided again into two classes.

There are papers like the P.S.E.A. "News" of the Pacific Gas and Electric Company, edited by the employees' organization. These publications abound in personal items about employees, printing their contributions with as little editing as the law allows, their poems, their children's pictures, and accounts of their outings and activities. It is a little country newspaper within the organization. Although of very little interest outside the organization family circle, it is perhaps the most appreciated type of publication issued

internally—as far as the effect on the personnel is concerned.

The other type is that put out by the management "on behalf of the employees." It is designed for the employee with an eye to the outsider under whose gaze it may fall. While ostensibly an internal publication, it may be compared to the school teacher when the inspector is present. This type of magazine is more on its good behavior. It has its sections devoted to employees' gossip; but the gossip is touched up where mother tongue has been weak. And generally, as in my own company's magazine, "Glow," of the San Diego Consolidated Gas & Electric Company, it devotes several pages to illustrated articles on company methods, properties, departmental functions, ideals, and aspirations. It is, in short, more a magazine and less a newspaper. It seeks to be instructive as well as entertaining, dignified as well as human.

External Publications

External publications also have dual personality. There is first, the quasi-external publication, such as issued by Western States Gas & Electric Company, Coast Valleys Gas & Electric Company, and others, a brief leaflet issued quarterly by the stockholders accompanying their dividend check. It aims to give in brief a review of the construction or expansion features of company activity, the state of its finances, and a caution or two as to the danger of letting go of good paying public utility stock in trade for "wild cats."

Other companies have extended these boundaries, notably the "Pacific Service Magazine," published by the Pacific Gas and Electric Company. This excellent magazine is published to sell the achievements, service and ideals of its company to its vast army of shareholders and to the influential forces of the community. While it is circulated to employees as well, it is designed primarily for external consumption.

Feature articles, well illustrated, written by authorities within the company, editorials of a high tone, and generally well edited and prepared copy may be used. The purpose is at once to impress and to influence toward building substantial good will. It is to give the reader a feeling for the soundness of the public-service institution and a respect for its high purposes.

Another type of external publication, the most ambitious and successful of which is to be found in "P.G.& E. Progress," is essentially for public consumption, truly a newspaper edited by the company on behalf of its customers. It found its beginnings in the small leaflet sent out with monthly bills, still in vogue in many companies. Its contents are helpful and instructive, its columns devoted to the better use of electricity and appliances. Economies which appeal to every housewife, recipes for cooking, and methods of doing housework electrically are featured. It carries also constructive articles on company methods and policies, tells how to read meters, apply for service, give notification of moving—all considerations which mutually benefit customer and company.

Excerpts from editorial opinions regarding public policy, municipal or government ownership, and other phases of activity are carried in its pages. New construction is detailed, plans for improvement discussed, public movements of merit are fostered. In effect, it is a truly community journal—serving that community which is the company's territory.

Internal-External Publications

And now for the hybrid. It is that type of internal publication at once internal and external, the best exemple of which is "San Joaquin Power" of the San Joaquin Light & Power Corporation. In this type of magazine are combined the attractive features of each distinct type, blended in proportion according to their value, the whole well seasoned with good judgment and dished up in attractive style. This type of magazine attempts the seemingly impossible task of reaching out one hand to the employees, another to the public, and a spare hand to the stockholders.

There is a definite section for the frivolities and personalities of the employee. There are sections devoted to interests of company and stockholder alike. And there are articles and features for the general public, showing the development of the community served by the company and, modestly, the part played by electricity, the master servant. The latter type of publication, seeking to cover so wide a field, requires much more tactful and versatile treatment editorially, but in many respects presents distinct advantages of economy.

Few doubt the value of house publications—no matter how modest circumstances require them to be. Rather it is "what type of publication" that is the question. It is well in such case to survey the field and select that type most urgently required, following, as circumstances warrant, with the other types, or else with gaining experience, essay by degrees the merger of them all in one, the internal-external "hybrid."

Who Shall Pay for Dealer Helps?

By M. W. SCANLON

DEALER helps, so called, include all such items as folders, window and counter displays, novelties, advertising cuts, street car cards, lantern slides, truck signs, calendars, mailing pieces, and outdoor posters. Price cards and catalogs hardly can be included in this list. Dealer helps are only such material as is circulated by dealers in retail selling effort. They are an economical aid to retail selling and therefore necessary.

Such material is subject to the wasteful or the saving element in the personal equation of each dealer to whom it is supplied. This is more likely to be a saving element if the dealer has a real financial investment in the material and realizes it. Even when a dealer has an actual money investment at stake, he often will follow least resistance and allow inefficient use of the material rather than spend the time and energy necessary to get the greatest benefit from it. Naturally this tendency is greater where no investment is involved.

Dealer helps are practically out of the question unless they can be produced on a large scale. The cost of quantities ordinarily sufficient for the demands of an individual dealer would be exorbitant. It is necessary, then, that they be financed and produced by some central agency.

If left to cooperative associations, the cost of the material is borne by the membership, which automatically answers the question, "Who shall pay?" Dealer helps produced by associations must be neutral in their appeals. This places them on a footing with the salesman who offers to sell a customer "any kind of an iron you want" without regard to comparative quality, durability, or efficiency. The salesman in this case has an opportunity to show several irons, but the cooperative dealer help is limited to noncommittal illustration and discussion. Consequently the burden of financing and producing dealer helps has fallen upon the manufacturers who have a definite prospect-satisfying and sales-making story to tell. And because dealer helps prepared by a manufacturer tell the story of that manufacturer's particular line, dealers are often inclined to ask offendedly why they should be expected to bear the advertising bills of "So-and-So Electrical Manufacturing Company."

A statement of the several functions in the process of placing the product in the consumer's hands may be put this way:

Manufacturer makes the goods.
Manufacturer stocks the goods centrally.
Manufacturer sells the goods to jobber.
Jobber stocks the goods sub-centrally.
Jobber sells the goods to dealer.
Dealer stocks the goods locally.
Dealer sells the goods to consumer.
Dealer installs and services the goods sold.

Each of these operations is an easily defined expense item. If any one of the three members of this chain offers to do any part of another member's work, a transfer of expense is involved and the second member profits.

Dealer helps are definitely an adjunct to the selling of goods to the consumer. But since it is uneconomical for individual dealers to produce their own folders, displays, etc., the situation requires that the manufacturer produce the dealer helps. This still constitutes an acceptance by the manufacturer of a portion of the normal function of the dealer, a favor from manufacturer to dealer.

Two principal reasons exist for the cost of dealer helps being placed on the dealer:

1. More careful and efficient use is made of material in which the dealer has his own money invested.

2. Dealer helps, being a retailing accessory, should be paid for by the one to whom retail profits accrue.

But logical conclusions also must cover the psychological considerations in selling. If dealers ever pay for all their folders and displays, it will be only as the result of a tremendously successful job of selling. They have become so accustomed to being supplied lavishly with dealer helps of all kinds that many of them have come to expect such helps as a divine right. They are willing to pay for the occasional display or novelty, but it is an expensive undertaking to sell them any large proportion of what they receive at anything like actual cost prices.

The experience of this company in selling the window display services and the illustrated letterheads is sufficient evidence of this obstacle. The actual cost of securing such window display service contracts as we have now in the San Francisco office is so exorbitant that there is little possibility of our realizing enough additional business to balance the account. For example: one of our merchandising salesmen working his territory was accompanied by a publicity division man for a week, and both talked the window display service to every dealer on whom they called. On the trip four displays were placed. Possibly one man could have done as well alone, if he had both the outside man's knowledge of the trade and the inside man's knowledge of the displays. Even so, the average would have been a display for each day and a half per man, and the cost per sale aside from cost of production, warehousing, and transportation would have been close to twenty dollars. Yet this seems to be the only way these displays can be sold.

The dealer believes sincerely that the manufacturer should provide for him, free of all cost, all the dealer helps he can use. In spite of this obstacle, it seems absolutely necessary that the dealer be called on to bear a portion of this expense, because the demand for this material is increasing to the point where its cost has become an extremely important item, and it is not infrequently that we receive requests for dealer helps worth ten to twenty per cent of the business that we expect to result. It takes only 200 folders of the black and white half-cent variety to eat up five per cent of the gross retail sales value of four $5 irons. The average electrical dealer spends less than two per cent of his gross sales in advertising locally for himself.

Probably the best we can ask is that the dealer accept a part of the cost of dealer helps. This secures from him a more vital interest because of financial interest, avoids partly the expensive operation of selling him something he believes should be given him, and at the same time gives the manufacturer a measure of much deserved relief. This sharing of expense should not be based on certain items but should be on a set basis for all items in order to be fully effective.

Reaching the Stockholder

By CHARLES HESTON PEIRSON

IN a modern sales organization, in which publicity, advertising and salesmanship are woven together for a particular purpose, it is impossible and futile to attempt to separate the strands. In discussing the subject of stock sales or "reaching the stockholder," from the standpoint of the publicitiy manager the existence of a permanent, efficient and agressive sales organization must be recognized as fundamental. Were it not so, it is doubtful if the most active efforts in publicity and advertising would be perceptibly efficient in selling conservative securities, of the non-speculative and non-spectacular class. In this conservative class are the public utilities of California and the United States, and the placing of their securities in the market involves a thoughtful transaction between the seller and buyer. In almost every instance they are culminated by experienced salesmen or the ordinary employee of the utility who has had some training in selling the company's stock to its consumers.

Having only a superficial knowledge of the stock-selling methods of other California utilities, I must confine this discussion largely to the activities of the Southern California Edison Company in placing its junior securities in the hands of the public, and of this public its consumers and patrons are the dominating element.

Historically, the story of the company's experience in the sale of its common and preferred stock runs substantially as follows: When in July, 1917, the Southern California Edison Company adopted the policy of selling its junior securities to its patrons and the public, it had approximately 2,000 stockholders, nearly all of whom resided in the East. The campaign of advertising and salesmanship scarcely had been organized when war necessity required the government to float enormous issues of Liberty Loan bonds. Actuated by patriotic motives, the company, like nearly all of the "hundred-percent" American organizations of its class, retired from active competition with the United States Treasury. It seemed manifestly unfair to push the sale of securities bearing a normal rate of interest against the securities of the United States Treasury, the proceeds of which were essential to the prosecution of the war. Thus it transpired that until after the armistice the company practically retired from all active stock selling, swinging the volunteer services of its organization and donating large volumes of advertising space that had been arranged for to the sale of Liberty Loan bonds. In the years of adjustment following the war money was in great demand for rehabilitation, and conditions were generally adverse to the marketing of securities. It thus resulted that from the year 1917 to the beginning of 1921 the company had secured only 4,000 additional stockholders, or a total of 6,000.

With the return of normal conditions, and with a seasoned organization of salesmen and a publicity program that functioned from the city to the smallest hamlet, the company began its actual stock-selling activities, adding 18,000 new stockholders, most of whom were consumers, and ended the year Jan. 1, 1921, with a total of 24,000 individual stockholders.

In 1922 this number was raised to 48,000 stockholders; in 1923 to 64,000 stockholders; and the year 1924 closed with 70,103 individual stockholders, of whom at least 90 per cent are consumers of the company's electric product, either by direct meter connection, or through the medium of some of the organizations that purchase current at wholesale and distribute it to the consumer. Since 1917 the total sales of junior securities have amounted to over $60,000,000.

While over 70,000 stockholders out of approximately half a million meters supplied by the company's electric product either at retail or wholesale seems quite an encouraging start, the company regards it as only a start. Theoretically it is assumed that every consumer should be a participating partner in the electric utility that serves him. The ideal public utility of the future is the one in which every consumer is a partner-stockholder.

While anything approaching saturation of stock sales is in the very remote future, this utility is continually endeavoring by more intensive and analytical study based on eight years experience to keep the volume of sales on the increase as well as to keep the sale cost down.

Fitting very closely into the methods which it is adopting is the long established plan of purchasing advertising space in annual blocks that can be consumed in such quantities and at such times as its use is most advantageous and keeping so far as possible away from "rate holders," standing ads or any of the forms of contract which compel the use of advertising when and where its value is negligible. In central and southern California, as well as in other parts of the state, there is a very great diversity of cropping seasons which have a most important bearing on stock sales. In a community where all the money is being used to grow a crop, there is little available for investment. When the harvest is over and its proceeds come home, the harvest money seeks investment. The company's security manager has worked out a few successful studies in alternating activities which seem to justify further and more comprehensive analysis. He maintains in the field what he calls the "flying squadron" of salesmen. The company is working on the amplification of this system by making its stock sales advertising conform in a large degree and be coincident to the activities of this flying squadron.

The phases of this alternation of activities which the sales manager has inaugurated can be illustrated by these three examples:

During April, May and June in the foothill regions of southern California he finds that money is normally plentiful and stock sales good, because it is at this season that the proceeds from Valencia oranges and other citrus fruits have returned to the community and are awaiting investment. During September, October and November the money from the harvest of grains, raisins and deciduous fruits is coming back to the growers of Tulare and Kings counties. In January and July the semi-annual interest on bonds is being paid, and consequently there is a surplus for investment in Los Angeles and the large residential cities of southern California.

By working his flying squadron and centering his sales activities at the centers where money is, so to speak, at leisure, far better sales results are obtained than would be possible in the territory where capital is engaged in the requirements of production.

It naturally follows that shifting large space advertising to stimulate the activities of the stock sales department to conform to the prospect-peaks in the rotation of the season's advertising has a much stronger pulling power than it would have if dribbled out in the communities where all the money of the people is in demand for the conduct of their own affairs. Such studies as this lead the company to believe that, as it reaches conclusions from exact analysis and bases its activities on proven data, it will continue to reach more and more of its consumers, and that each year will increase the number of customer-owners.

At this writing the securities manager, the advertising manager, and the publicity manager are collaborating in the preparation of a set of district charts which they believe will enable the general manager to see at a glance what has been accomplished in each of the thirty-one geographic districts in which the Edison territory is divided and enable him to determine with considerable exactness the field in which activities can be directed most advantageously.

It is proposed that each of these district charts shall show the district population; the number of meter connections; the total circulation of newspapers within the district, and so far as possible the financial status of the district and the number of company stockholders. Each of these statistical groups is to be worked out in percentages, each as relating to the other. For instance, the total newspaper circulation shown in its ratio to the number of stockholders would enable the publicity manager and the advertising manager to reach valuable conclusions as to the relative drawing power of newspaper advertising in each of the thirty-one districts. Naturally this knowledge will be a valuable guide in making up the annual advertising appropriation and will show where it is profitable to increase the amount of advertising. Efforts are being made to substitute exact knowledge for generalities and chance conclusions. From the very outset it has been the plan to meet advertising constructively. Its dominating note has always been "be a partner in the utility which provides your electric service," or "let your power stock dividends pay your power bills." The company always is striving to get away from the catch phrase, the "solving sentence," the platitude, and the slogan which advertising adventurers have worn threadbare, and to substitute constructive ideas which will stimulate constructive thought and cause the reader to apply the great principle of customer-ownership to his home and his business.

The preparation of advertising copy for a public utility company requires a deeper and greater range of economic thought than in the arrangement of announcements for ordinary commercial purposes. It is truly one of these occupations in which the more work you put into it, the more results you take out.

The writer is frequently asked these questions: "What effect has publicity on stock sales?" "What effect has stock sales on publicity?"

To the first question the most definite answer that I can make is to quote the investment manager who says, "It is only once in a blue moon that one of my salesmen has to sell the Southern California Edison Company to a stock prospect." Publicity and advertising has informed the public so thoroughly and saturated the community regarding the company, its projects and its service, that the salesman's task is very largely confined to a strictly business transaction. It is very much the kind of a transaction that would take place between a salesman and a customer who is deciding upon the purchase of a standard article.

It is the salesman, however, who in the majority of clases, closes all security transactions. It is only in rare instances that the company is able to trace any such results from advertising as would occur with a mail order house.

Of course, there are freak exceptions. Several years ago when the advertising campaign was spread out so that the smallest weekly paper in the Edison territory should have its proportionate share of business as based on its circulation, the company placed one or two exclusive advertisements in a small weekly paper with about three hundred subscribers. Within a little over a fortnight the district manager in this district sold something over $30,000 worth of stock over his counter. This result was so unusual that I gave it personal investigation, and the answer was simple. This lititle paper was circulated by rural free delivery among ranchers in a rich and highly productive agricultural community in which probably very few city papers were read. These prosperous ranchers had money at interest on low rate investments and, as they were practically all patrons and consumers of the Edison company, they had confidence in it. Seeing the announcement of junior securities at a better rate of interest than their money was returning to them, they went unsolicited to the nearest Edison office and became partner-stockholders in the utility which provided the electricity for their ranches. While such instances as this should never be taken as a guide for general advertising campaigns, it illustrates very forcefully the selling power of the advertising columns in the smallest legitimate newspaper, and emphasizes very emphatically that a field is most imperfectly covered when the advertising department depends on metropolitan or class papers to blanket a large domain.

The effect that stock sales have on publicity is a most interesting phase of this company's activities. The one hundred and seventy odd newspapers published in this territory are the medium through which the company is in constant communication with its stockholders. Edison stockholders are as numerous among their subscribers as the stockholders in their mutual irrigation companies; their citrus association, of their walnut growers' association, and consequently Edison news ceases to be regarded as a foreign activity, but becomes intensively local because it has a personal and vital interest to the editor's own constituency. It is my belief that as customer-ownership increases, and the publishers of the state come to understand that public-utility stockholders represent larger and larger blocks of their readers, the necessity for company publications and circulation will decrease.

Big construction projects are naturally of state-wide interest and are sometimes world news. The stockholder of the company which is engaged in these projects expects to see their progress related in his local paper. But big construction projects, in fact construction work of sufficient importance to become news, are too much like "angels' visits" to be relied upon as a constant source of news. Stock sales and financial activities, on the other hand, are so constant that they can be reduced to a news routine.

The annual budget is always the subject of a feature story. A month or two later the budget appropriation is split into the appropriations for construction and betterment in each of the thirty-one districts, making each an individual local story. An appropriation of several hundred thousand is as good a story for a small town as a new courthouse, and these "split budget" stories usually carry a seven or eight column banner-line head. Then there is the annual meeting of stockholders which, if properly localized, interests as many Edison stockholders in each town as would be interested in the meeting of the citrus association. Four good local stories are always available based on the payment of quarterly stock dividends. The company has so many stockholders in these small towns that the arrival of dividend checks is of interest to the banker and the merchant, as well as to the stockholders who receive them. Sometimes these are worked out so as to show just how much Edison dividend money will reach a town on a certain day. It is found that these little quarterly stories have about the best psychological effect of any that are sent out. They show the people of the community that the corporation is not engaged solely in taking money out of the town in the form of

light bills, but returning money to the consumer in dividend checks. These regular payments of dividends to Edison stockholders likewise have a tendency to create more Edison stockholders and to discourage people who put money into wildcat schemes that usually return assessments instead of dividends.

Speaking from the viewpoint of a publicity man, each day of a long life which has been exclusively devoted to writing and dissemination of the printed word adds to my belief that publicity is the great dominating medium by which the people en masse can be enlisted in the public ownership of utilities which serve them, in the cooperative movement in which we are all engaged, and cooperation is the antidote for anarchy.

Permit me to emphasize and underscore **dissemination and distribution of publicity,** for that impresses me as the great problem of publicity. Distribution is to publicity exactly what transmission is to electricity and what transportation is to commerce. Without a practical distribution system the best publicity mill that ever ground out copy is a power house without a distribution system.

Not a week passes by but some applicant, young or old, with a fine store of qualifications strikes me for a job to write publicity. They all want to sit at a desk and be generators and let someone else peddle their product. I have yet to find the first one who desires to buckle on the gaffs and go out and shin up a single new pole which will add to the distribution of publicity. I could go into a broadcasting station tonight and whistle into the microphone and fill every desk in the Edison office tomorrow morning with writers who in a week could paper the walls in every newspaper office in California with fairly good copy—but who would print it?

In eighteen years of corporation publicity work I have not found a single man with a single constructive idea which would work out as a practical invention for increasing the volume of constructive publicity, and for disseminating it through the twenty-five million dollars worth of newspaper properties and their circulation organizations which now exist within the state of California.

The impossibility, and the futility of any individual, or group effort to carry a message once or twice a month to the millions of people in this territory seems to me more and more apparent, as I squirm my way through the throngs and traffic of the great cities and ride the long road that stretches among isolated ranches from San Francisco to San Diego.

A regiment of orators talking six nights a week and twice on Sunday could not assemble this vast audience in groups of two hundred, and address them in fifty years. But this multitude of five or six million readers reads some one of the five hundred newspapers published in California once a day or once a week. If these papers, with their perfectly organized systems of circulation and distribution, carry our message of cooperative endeavor, "Prosper and help prosper;" "Live and let live," to their millions of readers, we shall have reached the stockholder, and the stockholder is the unit of state development and of community and national prosperity.

Public Relations from the Domestic Angle

By BEN S. ALLEN

THE family is the foundation of every worth-while institution developed by our present form of civilization. This is true of commercial as well as civic affairs and is not likely to be questioned by any serious student of industrial problems.

When master and man worked together in small industrial units they practiced, whether consciously or not, the same give-and-take found necessary in their more intimate family relations. As industry became more complex the trade and factory guilds began to take the place of the smaller units, but always paid due regard to the precious self-respect of both master and man.

The rift between the two began when Watts on one of the most momentous occasions in the history of the world saw the tremendous significance of the lifting of the lid by the steam in a tea kettle. The rift thus opened with the dawn of the machine age and steadily widened until it reached the dimensions of a chasm. This chasm has been the depositary of a huge mass of human wastage and suffering in the intervening centuries. Some of the finest minds of civilization have attempted to bridge the chasm between social and economic values with but little success until almost the dawn of the present century.

Yet a simple formula has always existed for the solution of a problem which has prevented modern civilization from becoming the fine flower of all civilizations. Nearly two thousand years ago it was preached from a Mount by the Master Economist of history. That formula has many variations from sacrifice to service, but always it implies the glory of individualism and the upholding of the self-respect of the human animal.

Master and man in the early days of small industrial units and trade guilds were terms of the same significance as parent and child, but in the machine age they took on the hardness of the material in which master and man worked. The terms connoted domination and subservience.

The fault lay in a wrong attitude towards the purpose of industry which was vividly defined when James Harvey Robinson wrote that the evils of the machine age began when men started to make chairs not to sit in but for profit.

The initial misconception began with the master, but it was not long before the man adapted the same impulse to his own necessities, and, needless to say, joined battle on a ground so narrow that neither side could fight thereon without disaster to both. But they have fought, and civilization for two centuries has been the victim of the most senseless warfare ever waged; a war which undoubtedly has done more to retard progress of civiiization than all of the wars of nations since international boundaries first were laid down.

A distinguished Englishman once said that the chief glory of America lay in the fact that the unendowed individual was given more chance of attaining distinction through his own efforts in this country than in any other nation of our own or former ages, and he expressed the opinion that for this reason alone our country had justified itself above all others. That was a proud tribute and one which we should cherish.

In this industrial age our greatest problem is the keeping alive of this precious individualism while subordinating it to the necessities of a complex industrial order. That is being done, and it is the proud boast of the public utility corporations that they have taken the lead in the effort to bridge the chasm between social and economic values. The bridgeheads on both sides are in place, and they are solidly built on piers of service.

Service is the modern economic application of the Sermon on the Mount. There is nothing mysterious about it, but the sound application of that little word is accomplishing wonders, making it appear almost miraculous.

Not so long ago the advocate of international peace exposed himself to ridicule, contumely and frequently to actual persecution. Today it is respectable to be a peace advocate. Similar was the experience of the pioneers in industrial reform who held that industrial warfare is even more insane than international hostilities.

It is a far cry in progress but not in time from the period when a utility perforce must justify itself apologetically as a servant of the public to the day when Samuel Insull, a great utility executive, could make the following forthright statement:

"I would like to refer to the question of publicity and public relationship. . . . It is of more consequence to our properties than all the rest put together. . . . For involved in the safety of our capital, the development of our business and the premanency of our business, above everything else, is this question of public relations. . . Our first duty is to see to it that everybody in our organizations, from the man at the top to the girl at the cash window or the boy who delivers bills, are so educated in the fundamentals of our business that they will carry home to all of our customers, which means to the whole of our respective communities, this primary fact: that the recognition of the duty we owe to the public, which we serve in every household, stands in our minds alongside of our duty to the owners of the properties we manage."

In the above argument it would seem that there has been a considerable swing away from the moorings of our premises. However, it is easy to swing back, because we started with the familiy, and we are com-

ing back to the domestic relations of a utility corporation.

The term, master and man, pure enough in its origin and application, does not fit in with our conception of the individualism of American democracy, so we have adopted a better term—management and men or men and management—it does not matter which, since they cannot be separated.

The term means no departure from proven economic practices, but does very decidedly mean progress in capitalistic society. Capitalism works now as it always has worked, clumsily, but it does work and no other system yet tried has worked. Its chief weakness lies in the fact that there are not enough capitalists. "Men and management" offers a solution, for the successful application of this modern formula implies stock ownership by employees. On that foundation your structure of domestic relations will stand the most furious storms, and about it should gather your public relations. But of course stock ownership does not stand alone. It is after all only a device dependent for its ultimate security on the human factor.

Every normal human being has the creative instinct always crying for expression. Give that instinct free play, is my plea to all public relations executives, who are laying the proper foundation through their own fellow workers for the success of their efforts. Avoid the word "welfare" as you would the plague and look askance upon the professional "Lady Bountiful" of either sex. Not patronage but shoulder-to-shoulder team work should distinguish company personnel activities. Let the employee create and develop ideas. Be ready with your help, but keep alive his self-respect by insisting that he follow modern practices by using a self-starter.

I shall enter into no details inherent in the subject of public relations from the domestic angle because the technique of the job is not important.

Your work is not a science; it is an art, and because of this fact your pathway is filled with stones, and a cross may await at the end.

We public relations men always show in the red ink of our ledger account, and no engineer can plot our progress; hence the stony trail we must pursue through directors' rooms and other places where we must justify our existence. But we have always cherished a secret ambition, and I feel the time is ripe to expose it. We want to flatten a triangle into a straight line. You all are familiar with the eternal utility corporation triangle made up of stockholders, employees and the public. There is an unending dispute as to which is the most important side of this triangle. It is our job to end this dispute by merging all of the sides into one common line. That is no easy job, and in doing it I recommend to my fellow public relations directors that they adopt as their staff of consolation the most inspiring verse in the most pessimistic book of the Old Testament: "In this war there is no discharge."

Advertising Must Sell

By SYDNEY W. GREEN

IN any discussion of the technic of advertsing the subject of media is one that naturally presents itself as of first importance. Because the electric light and power company is both a local and a foreign business, the problem of media in its advertising is more involved than in strictly merchandising advertising. The element of local good will demands that all newspapers be used in the territory served regardless of the fact that the field may be covered at a lower cost by using only the larger newspaper of more general circulation.

This situation in utility advertising carries the discussion of media into the department of public relations rather than that of the technic of advertising. Newspapers, magazines, direct-by-mail, radio, motion pictures and slides each have their place in utility advertising, but their use must be determined by the public policy angle as much as by a scientific investigation of the relative merits of the media based on costs. As newspapers are the most important media in the field of utility advertising, the preparation and placing of newspaper copy is a problem that has demanded considerable study on the part of the advertising department.

Back of every advertisement must be a basic idea. Why is the advertisement being inserted? The mere use of space in bombastic praise of the service or company may result in more harm than good. The public may regard such an announcement as contribution to the newspaper, no matter how sincere the writer may have been in the preparation of the copy. There are many interesting and instructive phases of almost any utility that can be told with profit to the company. The meat of the best advertisements are simple facts that have some application to the affairs of the public. The shortest route to the interest of another is through himself—by appealing to his self-interest.

While here and there the power company has some special service to offer that may be advertised advantageously, the greater portion of utility advertisements are institutional in character. The idea back of an institutional advertisement is to leave with the reader a favorable impression of the company or service. Popular subjects that have been featured in such advertisements are difficulties and danger attending the maintenance of service, and the personnel of employees rendering service. This copy has a cash register value when tied in with an offer to render a special service or to invite the public to become partners in the business. The mere story of how a crew of linemen resumed service after a severe storm is leaving the story half told. That particular effort was made to render service which the public expects. The idea will be more forcefully driven home when the public is invited to become one of this fearless, loyal organization through the purchase of stock. When a story of courage or loyalty is told there is no reason why the manufacturer cannot be sold the idea that electrical service in his factory has the protection of loyal power company employees. The personnel of the campany may be used to sell the housewife ranges, water heaters, or better lighting. The public expects to be sold something in every advertisement and there is a feeling of disappointment left in the minds of readers who read a well written story without the reason being made obvious.

A message or series of talks from the management or chief executive may be given in newspaper display copy with reasonable certainty that it will be generally read. Most people are interested in the big men who direct or control utilities. These talks may be made very personal and human, dealing with the problems of community, thereby breaking down the "soulless corporation" resistence. Each message should carry an invitation to become one of the stockholders of the company. A shareholder is much more interested in the company whose president and manager he knows than in the "Central Power Corporation," the personnel of which he knows nothing.

All this is good copy for the country paper and should be used there because rural districts are more often the hotbeds of criticism than are the cities.

Because the utility must use a large number of newspapers, mostly small country weeklies, the advertising man is confronted with the problem of having his carefully prepared copy printed so it can be read. To trust the average country printer with the reproduction of the best reprint copy is fatal. Even with the simplest layout it is not possible to obtain any degree of accuracy in advertising so handled. This situation means that the advertisements must be sent to the printer in the form of stereotype or electrotype cuts or a mat from which a stereotype can be made.

Cold type can be made to tell a story providing the story is interesting, but one good picture is worth a thousand words. While it is difficult to secure good pictures, it is even more difficult to have them properly printed. For newspaper printing, the most satisfactory results are to be obtained from line drawings. They print well and in case mats are used the results are generally satisfactory. Not so with halftones. Of course, the best illustrations are halftones from actual photographs that tell a story. But the utility using a string of weeklies is denied this means of picture reproduction unless the budget is sufficiently large to permit the sending of original cuts or a good grade of electrotypes to the country printer. Even then the results are terrible to contemplate in most of the publications. So the safest rule is to stick to line drawings, and send the country printer mats or stereotypes.

Very ornate copy or overly artistic arrangement very often distract the attention of the reader from the subject matter. Simple arrangement with not less than 25 per cent of white space is always good. Distinctive lettering in headings is permissible provided it is

legible, but the body matter should always be the plainest and most legible of type. The average reader absorbs the thought of matter printed in plain type, well spaced, much more quickly than when printed in quaint and queer letters. This is only natural as the eye has been trained to the plain types. Other forms offer resistence to quick reading.

Summarized, the technic of good advertising is first, thought; second, illustration; third, style and arrangement; and last but not least, good printing.

Proper Handling of Obsolete Scrap Material and Equipment

Report of Committee No. 1, Purchasing and Stores Section*

THE economical handling of scrap and obsolete material is one of the most important phases in connection with public utility company operation, and a subject which demands intelligent study. We have given consideration to this subject from four different viewpoints, each we believe having an equal bearing on the final result obtained.

1. Material and equipment committee.
2. Reclamation of material and equipment.
3. Handling of obsolete material, equipment and scrap.
4. Sale of obsolete material, equipment and scrap.

Material and Equipment Committee

We recommend as a means of eliminating obsolete and scrap items from store stock, the appointment of a Material Committee composed of the general storekeeper and representatives from each department having to do with the ordering, using or selling of material.

That the general storekeeper be appointed chairman of such committee, because of his more intimate knowledge of the stock. This committee should have the hearty cooperation of the executive officers and should be given sufficient authority to make their decisions as to future use or sale of material final. The duty of this committee would be to inspect each item of stock for which there is no call and to decide at that time whether it should be held for future use or sold.

When material is held owing to a difference of opinion, we would suggest the keeping of a record showing description, name of committee member dissenting, reasons for holding and date of inspection. This record should be referred back to the committee regularly for further consideration.

We also recommend that the Stores Department compile an Obsolete Material catalog covering items declared obsolete by the Material Committee, such catalog to be arranged according to classes and to be of loose leaf form so as to permit an economical revision and correction. Copies of this catalog should be furnished all storekeepers and departments engaged in the dismantling of material so that proper disposition can be made at the time of retirement, thereby avoiding duplication in accounting and inspection.

Items not covered in the catalog should be referred for examination and classification to the Material Committee at the time estimates are being made for this dismantling, (or if overlooked then at the time material is delivered to the storehouse), in order that the status of the material may be determined before the same is charged to Supply Account.

Reclamation of Material and Equipment

Reclamation of material is the recovery of money otherwise lost. It means the recovery of material unsuitable in its present condition for further use, but by intelligent expenditure can be renewed to serve its original purpose.

This committee recommends that work of reclaiming material and equipment be under the direct supervision of the Stores Department for the following reasons:

(a) Store organizations are trained for the work.

(b) Their knowledge of the materials used and the quantities necessary, enables them to determine the amount to be reclaimed, thereby preventing the reclaiming at a loss material not needed.

(c) The Stores Department is interested in the abuse as well as the use of material, and its supervision of reclaiming makes it better able to correct not only abuse in ordering, but also abuse in using.

(d) Due to the fact that a great deal of the work in connection with reclaiming can be done by unskilled labor, the Stores Department can do the work much more cheaply than any other department.

Adequate buildings and efficient equipment should be provided, and the work of reclaiming should be centralized as far as possible so that unnecessary supervision, duplication of labor organizations, and lost motion may be reduced to the minimum. The location of the reclamation plant should be handy to the scrap warehouse, as a great deal of reclaimed material comes from scrap. The foreman of the reclamation plant should be thoroughly posted in materials, their use and market prices. A very complete cost system should be installed so as to prevent reclaiming at a loss. All material reclaimed should be inspected by a competent person to see that it is in condition to meet the requirements of its use. An effort should be made to stimulate interest on the part of users of material, by acquainting them with the value in dollars and cents of material they are using, and by showing them the possible saving in investment by proper reclaiming.

Handling of Obsolete Material, Equipment and Scrap

We find that the real meaning of the word "scrap" is not fully understood by the average utility company employee. It is interpreted as something useless, without value and to be disposed of by throwing away.

We recommend first that all material known to be scrap, obsolete or for which the company has no further use, be carried in a separate account and not confused with the regular Material and Supplies stock. That users of material be advised of the importance of returning to the store everything taken from the line, regardless of its condition. Scrap metals should be segregated and classified as to kind and stores separately in bins provided for the purpose. Scrap bins should be located near loading platforms so that long hauls and duplicate handlings may be avoided. Scrap copper should be annealed and put in bales of approximately 200 lb. for convenience in handling.

All scrap accumulating on the system should be brought to one or more central locations for disposal, excepting in cases where the accumulation at plants or construction jobs is large and the sale could be effected more economically at that point. Sales of this kind should not be made however without an inspector on the ground to see that metals are properly segregated and usable material removed.

All scrap turned in should be carefully inspected so as to eliminate the possibility of junking serviceable material or material that might be reclaimed at a profit. Scrap should be cleaned up regularly and never allowed to accumulate in unsightly piles, detracting from the appearance of the company property, increasing fire hazard and delaying the use of the money its sale value represents.

In making carload shipments, cars should be loaded to the maximum, so that full advantage may be taken of freight charges. Owing to the fact that most kinds of scrap have a small market value, the use of up-to-date labor saving devices is recommended as a means of reducing costs.

Sale of Obsolete Material, Equipment and Scrap

We recommend that the sale of scrap be under supervision of the sales department, and not the stores department. One department will then act as a check on the other. No sales should be made by the sales department until released by the stores department. A very close cooperation should exist between the sales

* G. C. Robb, Pacific Gas and Electric Company, chairman; C. D. Weiss, San Diego Consolidated Gas & Electric Company; William Maddock, Los Angeles Gas & Electric Corporation; I. B. Walther, The California Oregon Power Company.

and store departments, so that sales may be made to the best advantage, in other words, by cooperation the seller might be able to get a better price for a piece of equipment as is, while in others the price might be more if dismantled. Scrap should be sold promptly and not held indefinitely for a possible rise in price. The profit and loss due to the rise and fall in price, will in the course of a year about equalize, therefore the advantage to be gained by frequent sales are:

1. Decreased amount of storage space necessary.
2. Reduction in labor costs in handling.
3. Elimination of shrinkage and possible loss by theft.
4. Prompt return to use of the money derived from its sale..

Stores Department Budget

Report of Committee No. 2, Purchasing and Stores Section.*

THE proper consideration of this subject should be taken up under three heads: (1) Organization of the supply department; (2) Control of the materials and supplies; and (3) Materials and Supplies budget..

Henry H. Farguhar, associate professor, Harvard Graduate School of Business Administration, in his book on "Factory Storekeeping" states:

> From a material standpoint the fundamental idea upon which war is conducted is so to organize and manage that the man at the front is enabled to keep his mind continuously on his main duty—the defeat of the enemy—without handicapping him in any way with questions of supplies of any kind. He should be able to absolutely forget material. Ideally and actually he should be able to reach his hand behind him at any time and receive exactly what he needs—no more, no less—at the moment. An over supply will impede his action, consume his time and attention, and result in waste; a deficiency either in quantity or in quality will render him helpless.

This then is the function of the supply department, and the underlying principle of material control, namely, having on hand at exactly the right time, just the right material, in the right quantity, at the lowest cost consistent with quality.

The function of the department should govern the organization. In attempting to lay out the organization any titles for the positions will be omitted, as those would necessarily vary in the different companies, according to size and other local conditions.

Responsibility should rest in a single individual, not in a number or in a committee. This indivdual should be an executve, preferably the head of this department only, although the size of the organization may preclude that. He may do the buying as well as have active charge of the storeroom; or he may supervise, handling the more important work, leaving the lesser details to minor employees and clerks; or he may be purely executive, outlining policies and supervising entirely, dividing the work under him to one or more executives.

Primarily, whatever the details, the authority and responsibility for material and supplies should be centralized in a department separate from the other departments, and the control vested absolutely in this individual.

The responsibility for what and how much is carried in stock should be his, and his word should be final—subject of course, to the revision of the general manager or board of directors. This does not mean that the construction, sales and operating departments should not make known their wants and their recommendations as to what material should be kept on hand. The head of the supply department should be a capable man of broad vision, acquainted with the company's history, plans, and finances sufficiently to cooperate thoroughly with the other department heads to the end that material may be on hand when needed, but excesses avoided. The standards and specifications would come from the other departments, and from such sources naturally would come the recommendations for what spare parts and spare units should be on hand. However the amount of the investment that easily can be piled up in the supply account, unless very carefully controlled, makes it necessary to put the burden of proving the need of adding to the supplies, upon the department desiring the same. The executive in charge of supplies should act as the check, for he, more clearly than any one else, can see from past experiences the evils of overbuying and overstoring, as well as know the humiliation of censure for not proving. The purchase cost of the article as well as the cost of storing—space, handling and insurance; the liability of deterioration; time necessary for delivery; possible substitutes already in stock; these are all matters that must be considered in connection with bringing of material into the supply account and are those with which the supply department is more familiar than other departments.

As an aid to the foregoing, and to fit in with it the Material and Supplies Budget is a necessary adjunct. "Buying by budget," says John C. Dinsmore, purchasing agent of the University of Chicago, "is nothing more or less than the careful tabulation in detail of the things that have been accomplished in the past, together with the amount that these accomplishments have cost side by side with conservative estimate of the things you expect to accomplish in the immediate future, together with the careful estimate of the amount of money you expect each item to cost."

With such a chart before them, showing in detail what had been anticipated during the past years, and then what had actually occurred, would not the supply department be in a much better position to forecast future requirements than simply going by guess? It is true that many unforeseen events quickly reverse the building progress of our companies, and often work carefully planned is of a sudden indefinitely postponed. Then again work of large moment is decided upon and undertaken upon short notice, but any growing organization has a certain more or less fixed accretion to its business, and has even a certain fixed amount of maintenance, repair and replacement work, which increases in a fairly regular proportion as the territory covered expands and the age of the material installed advances.

Most of our companies operate on budgets, which comprise major estimates composed by the several departments, and approved by the final authorities. These budgets may cover six months or a year, and even longer periods, but some definite projects are advanced, approved, and then the execution thereof planned in detail. This budget likewise contains estimates of operating expenses, and should have the details from the sales department of its proposed selling campaign.

It seems quite feasible for the supply department to take this budget when approved and obtain from the engineers in charge the list of material required for the jobs, the time table showing how the job is expected to progress, and when the different items are needed. With such information the supply department could map out a campaign for the period covered that will enable it to have the supplies when needed, without tying the company's money up for too long a period, without overcrowding the storerooms and without causing the construction department losses on account of non-arrival of material. The further in advance such information may be worked out, the better results may be accomplished.

Undoubtedly the supply department's greatest trouble is in keeping the amount invested in material and supplies at a reasonable and minimum figure, as the other departments, of course, wish material at hand when needed, and are apt to lean to the side of overages rather than shortages. Is there any better way of keeping down this investment, than by having a routine whereby it is necessary for the other departments, their budgets approved, to furnish the supply department with material details for the different projects? Such a record over a period of years would be conclusive proof if an over-investment or a shortage of material occurred as to who was responsible therefor.

By far the greater part of the work of construction is carefully planned. Sales campaigns of the commercial department likewise are outlined well in advance. and even much of the maintenance of the operating department is worked out in advance. Hence it is not at all impossible for these departments to furnish considerable details relative to material demand, which leaves an opportunity for the supply department to budget its demands.

The work in the supply department of making a budget should be gone over carefully, but need not be at all elaborate. A card or loose leaf ledger sheet would be made up for each item which should show in the beginning, by periods, the consumption for a

*C. A. Kelley, The Southern Sierras Power Company, chairman; W. J. McCullough, Southern California Edison Company; D. P. Mason, San Joaquin Light & Power Corporation; I. B. Walther, The California Oregon Power Company.

past number of years, with average prices for each period, the source of supply, probable time of delivery, the quantity on hand, and then the probable future requirements for the periods the budget covers, detailed month by month, or period by period, if a shorter or longer time was better adapted to the company's plans. The probable future requirements may be further segregated as to whether needed for a large specific job or for general small extensions or maintenance and repair work. This segregation would assist revision of the budget to meet sudden changes in general commany plans. Information if possible relative to the past history should be shown for the same period as the estimates for the future. As history progresses the actual data relative to the purchase and use of the item should be placed opposite the estimated, and running a period of time, this would be invaluable and to a surprising extent enable accurate planning or budgeting. Estimated pricing of these cards would make it possible to furnish the financial department with a forecast of money needed.

The material and supplies budget should also contain an estimate of the money necessary for salaries, rents, insurance, equipment, and miscellaneous expenses, detailed month by month.

Spare parts for machinery and parts of machinery carried and accounted for by the supply department form a part of the total investment in materials and supplies. Under this category should be included spare substation transformers (if carried in materials and supplies and not property), as they were purchased for a particular purpose and cannot be used generally. These items should be carried in a separate class from the general supplies and should be budgeted (planned for) separately. The ordinary distribution transformers and all meters however, should be controlled and budgeted as other supplies, for an overstock of these items is a greater possibility than any other items, and on account of the individual costs a greater menace to over investment.

The budget can be made a great aid to economical and efficient management of the supply department, and like all work of this department must be undertaken in considerable detail, however the fact must be borne in mind that too much detail in connection with smaller items might raise the cost considerably above any benefit to be derived. In such cases general amounts and costs should be entered.

Standardization of Material and Equipment

Report of Committee No. 3, Purchasing and Stores Section*

THIS committee recommends the appointment of a standardization committee, composed of representatives from the engineering, operating, construction and stores department. The duty of this committee would be to investigate each item or article now in use as to its quality, cost and purpose for which purchased.

In selecting a standard material for a given purpose, it is necessary to study it from several points of view:

1. How many uses can this material be put to?
2. What other materials resemble this material and can the one be substituted for the other?
3. What quality of this material will be good enough for the purpose it is to serve?

When a standard is decided upon, a written description should be prepared specifying just what is wanted. When certain items have been agreed upon as standard, the responsibility for enforcing their use should be that of one of the company executives, for standardization can only be effective to the extent of its observance. When standards are changed prompt notice should be given the stores department and they should be instructed as to whether the stock on hand, or that which might come in from the system, is to be used or considered obsolete. When the market conditions are such that a standard item cannot be procured, the standardization committee should pass on the material to be purchased for temporary use.

When the need for a certain item of material passes, due to change in construction methods, the stores department should be advised of the discontinuance of the article so that immediate disposition can be made of the stock on hand. In agreeing upon an item to be considered standard, the committee should merely specify the article but not the brand to be purchased, as this would eliminate competitive bidding.

Some of the advantages which would result from standardization might be summed up as follows:

1. Material most adaptable for the purpose intended would be furnished.
2. Reduces the number of items carried in store stock and as a result lessens the material and supplies investment.
3. Decreases the number of requisitions, thereby reducing ordering, purchasing, accounting and handling costs.
4. Makes the preparation of estimates more simple.
5. Permits larger purchases of the one item adopted as standard, which means a better price on account of being able to take advantage of quantity discounts.
6. Less storage space is necessary.
7. Shelves are kept clear of slow moving and obsolete material.
8. The labor cost necessary in ordering, purchasing, receiving, inspecting, testing, disbursing and accounting is greatly reduced by the smaller number of requisitions placed.

*D. P. Mason, San Joaquin Light & Power Corporation, chairman; L. S. Jones, The California Oregon Power Company; C. R. Eccles, Western States Gas & Electric Company; G. C. Robb, Pacific Gas and Electric Company; F. F. Henry, Southern California Edison Company.

Inspection and Testing of Material and Equipment

Report of Committee No. 4, Purchasing and Stores Section*

THIS committee recommends that a thorough and practical system of inspection of all materials be installed that will cover quantity, quality, and serviceability of all miscellaneous materials and supplies. All purchases should be made according to definite standards and specifications and all materials and equipment received from vendors must be inspected and tested before accepted.

These tests and inspections may be made during the course of construction at the manufacturers' plant, or after manufactured, but before shipment, or after receipt at destination. The nature of the material and the process of manufacture will often determine which of these tests is preferable. Tests during construction and before shipment are generally of a technical nature and should be made by the company's own engineers, or by outside testing engineers employed for that purpose. Tests at destination requiring technical knowledge should be made by the department qualified.

Those responsible for the tests and inspection should be furnished with copies of the purchase orders and the standards and specifications upon which the material was bought. The reports of these tests and inspection should be brief and to the point, so worded as to indicate clearly whether the material or equipment conforms to the standards and specifications.

A copy of these reports should be furnished the supply department, as only in that way can the purchasing agent know that the manufacturers and vendors are shipping what is wanted and paid for.

Visual inspection by the receiving department and storekeeper should be made for breakage, shortage, overage and to determine whether the material meets specifications. In this storekeepers should be governed by their personal knowledge obtained by experience and through daily contact with men who use the material.

Chemical tests by the chemistry department should be made of paints, oils, creosote, rubber, leather, pipe-covering material, soap, etc. This department should also make periodical tests on the galvanizing of standard line hardware.

Mechanical and electrical tests are to be made by the department responsible for technical testing, to determine strength, power, conductivity, insulation, etc. This will cover such items as line hardware, transformers, regulators, switches, motors, compensators, street-lighting equipment, transformer oil, switch oil, rubber gloves, etc. Metallurgical tests should be made of iron, steel, welding rods, etc. Miscellaneous items, such as

* C. R. Eccles, Western States Gas & Electric Company, chairman; D. P. Mason, San Joaquin Light & Power Corporation; C. A. Kelley, The Southern Sierras Power Company; C. D. Weiss, San Diego Consolidated Gas & Electric Company.

pipe fittings, poles, crossarms, lumber, tools, lamps, and other electrical supplies, are tested under the supervision of the stores department.

The following shows briefly for what certain items of material are tested:

Cast iron pipe is tested for breaking strain, deflection, tensile strength, bad beads, core rubs, core swells, bad fells, and mold scabs.

Cement is tested for fineness, consistency, composition, specific gravity and time required for setting.

Copper wire is tested for its tensile strength, conductivity, uniformity in diameter, smoothness and condition of joints.

Transformers are tested for core loss and exciting current.

Meters are tested for their accuracy.

Transformer oil should be given insulation tests.

Lubricating oil should be given viscosity, flash and fire tests.

Crossarms should be tested for strength, and should be closely inspected to see that they meet specifications.

Poles should be tested by an experienced pole man for dead timber, worms, breaks, dimensions, etc.

Pole paint should be tested for penetration qualities, weight, film, drying time, persistency of color and life of service under salt and dry air conditions.

Wood pins should be inspected for dry rot, knots and damaged threads.

Steel insulator pins should be tested for strength and all studs should be tightened to prevent them from working loose on the line.

Street series lamps should be tested before placing in stock to determine whether any tips are broken and to detect defective seals and broken films.

Supervision of Materials and Equipment

Report of Committee No. 5, Purchasing and Stores Section*

THE intended subject for this discussion was "Should all material and equipment, whether in the store or applied on requisitions and shipped to the job or district, but for some reason not used, be under the supervision of the stores department?"

Using this interpretation, this committee makes the following recommendations:

The general storekeeper shall have entire charge of all material belonging to the company, which is not actually in use, regardless of location.

Our reasons for making this recommendation follow:

1. The stores department was organized primarily to handle the material and equipment required for use by the various departments, because experience has proved to the satisfaction of the management of all large concerns that operating, engineering and construction men give first consideration to the operating, engineering and construction problem and only afterward do they handle the material accounting which, nevertheless, is of such importance that it cannot be placed second to any of the activities of the departments mentioned.
2. The stores department organization is composed of men trained in the ordering, receiving, disbursing, reclaiming and accounting for material.
3. In order to render the most effective service, which means a sufficient supply of material with a minimum investment, there can be no intermingling of activities or responsibilities.
4. The physcal handling of material is vital to a successful regulation of the supply, and must be performed by men trained in the work, if the best service is to be obtained.
5. The general storekeeper is the one person in a position to know of excess or idle stocks and consequently is the one person who can reasonably be charged with the responsibility in question.
6. With the supervision of unapplied material, regardless of location, under the general storekeeper, and the fact that all requisitions come to the stores department, he is able to apply any excess or idle stock, eliminating the purchase of new material and a needless expenditure of money.
7. The costs of material and equipment used, as well as payroll costs, must be accurately reported to the auditing department, and it is the duty of store men to see that proper reports of such costs reach the auditor.
8. Should there be any question as to whether the stores department should be in charge of all materials regardless of location, a trip around outlying properties may be somewhat of a revelation. Such an inspection will reflect excess stocks and piles of junk lying around in back of buildings, under benches, etc., the value of which may run into thousands of dollars. Conditions like this can and should be corrected, however, if no particular official of the company is charged with the responsibility, the following, an actual experience, will illustrate what may be expected.

At a small power house there were found five new garden rakes and nine new hose valves, requisitions for which had been duly approved by department heads and charged to operating accounts. If such conditions are permitted, does it not encourage both physical and mental, as well as moral slovenliness? With such conditions existent, a storekeeper cannot be honest with himself or with his company, and cannot feel that he is conducting the business of his department in such a way as to merit the approval of the company officials or the California State Railroad Commission. Furthermore, the employees, young people in many instances, will quite likely allow their personal standards to be influenced by the seeming indifference on the part of the company with regard to the careless expenditure of money.

* W. J. McCullough, Southern California Edison Company, chairman; R. E. Thompson, San Diego Consolidated Gas & Electric Company; William Maddock, Los Angeles Gas & Electric Corporation; I. B. Walther, The California Oregon Power Company.

The Procuring of Material and Equipment

Report of Committee No. 6, Purchasing and Stores Section*

MATERIAL procurement is of vital importance to the stores department, for upon it rests largely the success or failure of material control. It is also quite important from a company point of view because of the fact that delayed shipments mean a halting in the work and an added cost in construction. Requisitions are prepared and placed on the purchasing department, with only sufficient time to permit reasonable deliveries and if constant delays are experienced, it results in increased orders with an unnecessary added investment.

Since the general storekeeper is so vitally interested in his stock and has a much better idea of immediate requirements, we recommend that the tracing for material be under his supervision. We believe that a very close follow-upon system should be installed. This system should be that all purchase orders specifying a certain date of delivery will come to the tracing department desk, on that same date, or in advance if the case is one of an urgent nature and it is desirable to hasten delivery.

There will be cases when the construction program is changed, and the necessity for the material eliminated; this the general storekeeper will know and with the tracing being done in his department, deliveries may be held back or orders cancelled. The matter of tracing should never be permitted to become a mere routine for when this stage is reached the plan becomes ineffective.

A great deal depends upon the purchasing department in the matter of delivery. Good buying does not mean necessarily purchasing at the lowest market price, but rather at the lowest possible price consistent with the requirements of the requisition.

In placing an order, the purchasing department should be careful to select a vendor who has rendered efficient service in the past and one with a reliable reputation.

When a vendor, through repeated failure to meet its obligations has proved that its promises cannot be re-

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lied upon, we suggest a discontinuance of business with this firm, until such time as we can be assured that any agreement it might make will be lived up to, barring, of course, conditions over which it has no control.

Material and Equipment Handling Devices

Report of Committee No. 7, Purchasing and Stores Section*

THE type and amount of equipment necessary for the economical handling of stores department material, depends largely upon the quantities and weights of material to be handled, the storage space available and the location of buildings and yards. In order that the production and operating costs be kept at the minimum, it is just as important that the storeroom be equipped with up-to-date equipment which will save time and labor, as it is for the shop or construction department to be furnished with the proper tools and machinery.

Ample room to have a place for everything and everything in its place is the only way a store can be operated economically and with the minimum stock. Buildings should be of sufficient size to permit a segregation of stock. Suitable yard space should be provided for the proper storing of such material as cannot be placed in the warehouse. There should be trackage facilities so that cars can be placed at the warehouse platforms, thus avoiding extra handling.

Locomotive cranes are recommended for all general work for the reason that in addition to answering the purpose of handling all heavy material by power, these cranes can be used for yard switching and moved conveniently to different places where needed. They are of especial value in the loading and unloading of poles. The handling of scrap by hand is a tedious and expensive operation and it is recommended that in companies where the quantities of this kind of material to be handled are large, that the locomotive crane be equipped with generator and magnet.

Overhead traveling cranes should be installed over transformer storage space for use in handling heavy equipment such as transformers, switches, regulators, etc. Where the storeroom is small and the use of traveling cranes unwarranted, we recommend the motor driven chain hoist, of sufficient capacity to meet requirements

When yard space is limited and the installing of locomotive cranes impossible, we suggest an 8- or 10-ton capacity stiff leg derrick, with an 80-ft. boom, operated with an electric driven hoist. This device will prove a labor saver in the handling of poles, wire, pipe and heavy material. Jib cranes mounted on trucks or trailers are of great value in picking up heavy materials.

The automatic scale is of particular advantage in a storeroom where much weighing has to be done, for the reason that the weight automatically shows on the dial thus eliminating the time lost in balancing and putting on extra weights.

In determining the quantity on hand of such items as nuts, washers, etc., where the time necessary to count makes the cost excessive and it is desirable to compute from weight, the counting machine is recommended. These machines are arranged to work on certain set ratios, usually ranging from 10 to 1 to 200 to 1. A scoop hangs on the beam which acts as a counterpoise. The weight of the contents of the container which is placed on the platform is balanced by a small quantity of the same article placed in the counterpoise pan. The contents of the pan are counted and multiplied by the ratio of the machine and to this is added the number of articles in the counterpoise pan.

The use of lift trucks in moving heavy material such as switches, transformers, etc., from one location to another is very desirable. Where the quantity of material handled is large, much of it of heavy character, the use of electrically operated tiering or lifting trucks is recommended. They can be used to advantage in not only tiering such items as wire and cable, but also in loading trucks where the store floor is not elevated to truck level. Where crossarm timbers are purchased in the raw, the manufacturing being done by the company, cut-off saw, rip saw and boring machine are recommended. The use of a crossarm painting machine has shown considerable saving. This machine is constructed so that the arm passes through an enclosure where the paint is sprayed to all four sides at the same time by means of an electrically driven force pump. This machine can be connected to the gravity conveyor and the arms unloaded, painted and stacked in the one operation. As an explanation of the saving effected through the use of this machine the following might be of interest.

Using the old method of painting crossarms by dipping, five men will paint and stack about 1,000 arms per day, or it would require approximately one and one-half days for these men to unload, paint and stack a carload, or 1,500. By using the gravity conveyor and the painting machine, the same men will do the work in less than five hours. In addition to this saving of labor, there is a saving of about 25 per cent in the amount of paint used.

The painting of poles by the use of compressed air has proved quite successful. By the use of this device one man can paint approximately seventy 40-ft. poles in a day, while with the brush it will take two men the same length of time to paint 65. We recommend the use of this equipment not only because of the saving in labor effected, but for the reason that the work is much more satisfactorily done, the cracks and checks being completely filled.

Gravity conveyors are used as a means of saving in the unloading of such material as cement, crossarms, boxes, etc. Oil dryers and filters, for the purpose of purifying and filtering transformer oil should be installed. Electric trucks and trailers are strongly recommended for use in moving material within the storeroom and from one place to another in the yard. Rubber stenciling outfits and paper stencil cutting machines are of advantage in the shipping room. Wire measuring machines should be a part of the equipment of every store, because of the time saved in filling orders.

In addition to the above, the storeroom should, of course, be well supplied with items such as two and four-wheel trucks, small scales, etc. In the office there should be a sufficient number of typewriters, adding machines, calculators and comptometers so that clerical work may be handled efficiently.

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Stationery and Printing Department Economy

Report of Committee No. 8, Purchasing and Stores Section*

IT is the opinion of this committee that the handling of office supplies, stationery and printing, in our companies is of such importance as to effect a large saving if properly organized and sufficient attention given. The function of the stores department is to receive, ship and account for material and supplies and inasmuch as it is set up to perform this work, it is believed that the ordering, receiving, storing, distributing and accounting for office supplies and stationery should be placed under the jurisdiction of the general storekeeper.

Stationery and office supplies should be a separate section in the stores organization, and should be supervised by a man thoroughly conversant with this line of work. Stationery is used by all departments from the office of the president down and is subjected to a greater amount of waste than any other item of supplies, and for this reason should be carefully watched. Again, stationery supplies are made up of many small items, each in itself of small relative value, so that no striking economy can be effected in any one place, but the aggregate loss through careless handling is large. One of the most effective means of economizing is through the adoption of standards.

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Careful consideration should be given the size of all forms, so that they may be cut from stock size paper without waste. This might be accomplished by placing the responsibility with one man, to whom all new or revised forms would be sent for approval as to size and grade of paper, before being sent to the printer. This man should be familiar with stock sizes and grades of paper. Another method by which economy can be realized is by minimizing, as far as possible and practical, the number of forms used.

The grade of paper upon which a form is printed should be determined by the purpose for which it is intended, if for temporary purposes, a lower grade, and if for a permanent record, a better quality. Whenever possible, forms should be consolidated.

It is generally agreed that in revising old forms, or preparing new ones, they should be correct in every detail before sending to the printer, so as to avoid loss of time and money in altering proofs. Only standard forms and those not subject to revision should be printed in large quantities, as a noticeable loss in money is incurred in writng off surplus stocks and discarded forms. Wherever possible, forms that have been discontinued should be cut up and padded for use as memorandum or scratch paper. When it is necessary to print instructions covering use of a form, the instructions should be printed on the face, rather than on the back, so as to eliminate the necessity of running through the press a second time.

Stationery forms and paper should be kept wrapped, and not open on the shelves, so as to prevent dust settling on the outer sheets, resulting in a loss of the first sheet, or several sheets if padded in sets.

The extravagant use of carbon paper is a serious waste in most company offices. A point which might be considered with a view towards economy, is the centralizing of all stencil and duplicating work so that less machines will be necessary and so that there will be continued use of not only the machine but the operator. There is a difference of opinion as to whether it is economical to manufacture our own typewriter ribbons, ink, mucilage, etc. Some companies are already doing this and claim a considerable saving is effected.

Typewriter ribbons are discarded by the stenographer at any time without question, regardless of the fact that they are but partially used. This lack of economy should be corrected by having someone in authority inspect all returned ribbons before new ones are issued.

There should be attached to the stationery and office supply section one or more mechanics, capable of overseeing and repairing office equipment such as typewriters, calculators, comptometers, adding machines, etc., so that they may be kept in first class working order. It is just as necessary that careful attention be given to this class of equipment as that given to motor vehicles and other machinery which is in continuous use. We all agree that the service rendered by the distributors of this class of equipment is only half hearted and generally unsatisfactory.

The stationery and office supply storekeeper should be privileged at all times to offer suggestions and recommendations in connection with the purchase of these commodities, as his experience enables him to know pretty well what would be best suited for the purpose used, and whether or not efficient service is being obtained from the articles he carries. For instance, if a department is using too much carbon paper or too many typewriter ribbons in its usual duties, he can investigate as to the reasons, whether due to poor quality or careless handling. He should have authority to survey the stationery and office supplies in any department at any time, as to quantity and condition of stock, and to question any requisition reaching him that in his belief calls for too large a quantity, or is in any other way unusual.

Printing Department

A print shop operated in connection with the stores organization has demonstrated a large saving. We do not think it would be economical or advisable for the average public utility company to set up a printing department to handle its full requirements, as there would not be sufficient work to keep the machines and men busy all the time. Also certain branches of the work require high salaried mechanics. We do, however, recommend a plant consisting of two or three different size presses, a power cutting machine and a padding machine, which we believe will be sufficient to handle a greater part of the work.

A few of the advantages derived through the operation of a company printing plant might be stated as follows:

1. Costs are reduced.
2. With our knowledge of costs we are better able to check the quotations of dealers to whom we must give a part of our work.
3. There is no delay to company requirements.

The previous paragraphs of this paper deal entirely with the economies which might be effected in the ordering and handling within the storeroom, but the possible economy with the greatest possibilities lies in the distribution. If we distribute excessively, we buy excessively, for the demand governs the buying. This results in an over investment which costs the company in interest, taxes and insurance unnecessarily.

For this reason a very complete system of checking requisitions should be inaugurated. There is a question as to just how an intelligent check of stationery requisitions can be made, due to the fact that the storekeeper has no definite knowledge of the various office requirements. A system might be installed whereby the head of each department or office be asked to furnish a list of his monthly requirements of each form, office supplies and blank sheets, also the number of employees in his office. Provided with this information the storekeeper could cut down or question requisitions calling for quantities in excess of the amount shown on list furnished by the department head. It is common practice, however, for offices to order a certain number of each form and so many pencils, pens, etc., each month regardless of the amount on hand, so our systematic check of requisitions fails unless followed up by a periodical check of stock at each location. It should be the duty of someone to make this check and he should have the authority to return all stock found in excess of requirements as shown on the department list.

Purchasing Department Organization

Report of Committee No. 9, Purchasing and Stores Section*

IN our report on purchasing department organization, we have been governed by the knowledge that an organization suitable for one company would not be suitable for another and have, therefore, touched only on the essential requirements as to personnel and routine, leaving the completing of the detail, as to number of assistants and record requirements to the individual company.

There are many factors entering into the organization of a purchasing department, among which may be included:

1. Whether the company or corporation of which it is a part, is of large or comparatively small magnitude.
2. Whether the company or corporation is located in or adjacent to a large business center.
3. Whether or not the general store is a part of the purchasing department, operating under one head.
4. Whether it is the policy of the company to maintain large stocks.
5. Whether shipments are made direct to the field by the vendor.

There are other factors which cannot be spoken of here because of lack of space.

Assuming that the purchasing department operates as a separate departmental organization of the company, its personnel should consist of the purchasing agent and his assistants or buyers, with sufficient clerks, stenographers and typists to effectively and economically carry on the work of the department under the general direction of the purchasing agent. The duties of buyers should be classified as to materials and supplies, thereby enabling the buyers to become more or less experts in their respective lines. Care should be used, however, to the end that the organization be so trained that in the absence of one or more employees whether they be buyers or clerks, that those remaining may be sufficiently familiar with the work

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of the absentee that his work may be readily taken over and carried on without loss of time or efficiency.

It goes without saying that one of the first essentials of a purchasing agent and the entire buying personnel is that they have the confidence of those with whom they come in contact. This applies not only to the vendor or individual himself, but to his representatives as well, as it is through him that the personal contact is made. In order to secure this confidence square dealing and courteous treatment should be the slogan. With this platform the purchasing agent commands the respect of those with whom he does business, resulting in better relationship between his company and the vendor. With a man of such a calibre at the head he will tolerate nothing less from his assistants.

Inasmuch as centralized buying is the reason for existence of the purchasing department and the needs of the company's store and several departments are made known to the purchasing department by requisition, care should be used in the preparation of such requisitions, thereby enabling the purchasing department to intelligently handle their requests to the best advantage.

Next in importance is the purchase order, its size and form and number of copies depending upon predetermined policy. It should, however, be so constructed and worded as to enable the vendor to handle it with dispatch and the least possible chance of misunderstanding or error. In addition to quantity, description of material and destination of delivery, the purchase order should show price agreed upon, terms, f.o.b. point, shipping or delivery date agreed upon, routing and any other information that will insure proper filling and delivery of material ordered. Considerable time and expense may be saved by use of window envelopes in mailing. The use of the acknowledgment of order form is a moot question.

The securing of bids should be handled by the buyer responsible for the purchase of that particular commodity, written requests where necessary being made over the signature of the purchasing agent and quotations being adddressed to him personally, that he may be continually in touch with all matters pertaining to purchases made and to be made. It frequently happens that the commodity to be purchased is of a technical or special nature, in which event, all bids should be referred to the engineering committee or the individual from whom the request for bids or purchase emanated. Upon completion of the transaction, all quotations should be filed with a copy of the order appended thereto.

It has been found quite an advantage in one large utility to have tracing on the vendor done by the general store, that department having in its possession a copy of the order and is better acquainted with the urgency of the situation and can act accordingly. Tracing of materials for departments other than the general store should be done by the purchasing department. In either case, this duty should be charged to a live up-to-date person, with good judgment, diplomacy, and capable of writing a good business letter.

The advisability of keeping a price record is obvious. The use of a card or loose leaf ledger system may be employed. This price record should show date of purchase, price and quality, f.o.b. point, etc., such data being secured from purchase orders or invoices, the former medium being most satisfactory, assuming prices are shown thereon, as it does not delay the handling of invoices and in consequence possible loss of discounts. With reference to basis of price, it cannot be arbitrarily said as to whether it is of greater advantage to secure prices f.o.b. point of shipment or destination as circumstances under which shipment is to move would govern.

So far as general routine is concerned, that will, of course, depend upon the particular set-up of the organization and is not important, as ideas along this line will always differ. However, in a general way the purchasing department, while being the spending organization of an institution, can by careful and honest dealing, straight forwardness and square shooting, not only be the medium of saving a company a vast amount of money but become a friendly and important contact for the company with the public at large.

Stores Department Organization

Report of Committee No. 10, Purchasing and Stores Section*

IT is impossible, due to difference in size and the varied conditions under which public utility companies operate, to outline an organization that would be applicable to all, but we will endeavor to state the personnel and departments necessary to effect an efficient working force.

General Store

General Storekeeper: The general storekeeper should be the active executive of the organization. He should have a thorough knowledge of all matters pertaining the ordering, handling, distributing and accounting for materials and it should be his duty, not only to provide and care for material, but to know that it is properly applied. It also will be his duty to maintain organization, anticipate demands, provide suitable facilities, curtail expenses, question unnecessary purchases, reclaim material and arrange for the sale of scrap and obsolete items.

Assistant General Storekeeper: He will assist the general storekeeper in the exercising of general supervision and act during his absence.

Traveling Storekeeper: The traveling storekeeper should be the personal representative of the general storekeeper. He should supervise physical and accounting conditions of all district or division stores. He should have a general knowledge of materials and be conversant with the complete store organization.

Chief Clerk: The chief clerk should be in charge of all clerical work. It should be his duty to audit invoices, make payrolls and prepare statements of cost, stock balances, etc.

The usual stores office force, we believe, will be more efficient if a well defined division of responsibilities is placed, and with this in mind we would suggest the followng bureaus:

1. Accounting bureau.
2. Requisition bureau.
3. Payroll bureau.
4. Inventory bureau.
5. Stenographic bureau.
6. Filing bureau.
7. Mailing bureau.

The employees of these bureaus would report direct to the assistant general storekeeper and chief clerk.

The location of the general store is of vital importance as upon this hinges largely the efficiency of service and the costs in transporting material. It should be located as near the center of the territory covered as possible, provided such location does not increase freight charges on received material more than the saving effected by such location.

When the territory covered is large, it is sometimes advisable, owing to market conditions, to have a second general store, but this is not good practice if it is possible to avoid, as it results in duplicate organization and an increase in material and supplies investment.

With a view to economy, we recommend that store buildings be of sufficient size to permit the proper segregation of materials. The real purpose served by the general store is promptness in delivery, and its system must be such as to permit of no delay in shipping. With this in mind we suggest a sectional arrangement of all material, with a view of economy in handling and with a further view of having a man in charge of each class of material who should be an expert in this particlar class, and who should actually handle it, both in and out.

As an explanation of the sectional arrangement referred to above and a probable convenient segregation as to class, the following might answer.

Sec. 1. Motors, motor starters, regulators, transformers, etc.
Sec. 2. Meters, current and potential transformers, telephones and parts, etc.
Sec. 3. Hardware, line construction and miscellaneous material.
Sec. 4. Electrical material.

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Sec. 5. Cross arms, guy covers, wood pins, poles and lumber.
Sec. 6. Cable and wire.
Sec. 7. Stationery, office supplies and fixtures.
Sec. 8. Scrap and obsolete material.

Each section should be operated as a separate store, the section storekeeper keeping his own stock book. He should be furnished with a copy of every order for the purchase of material for his section. He should record, receive and check all material and see that it is properly placed on the shelves. At the end of each month he should inventory his stock, enter on his stock book the amount necessary to order to meet requirements for a certain agreed upon period, also the amount of unfilled requisitions and turn over to the requisition clerk who will check each item, making warranted changes and corrections and will then prepare requisitions to cover, inserting in the stock book the requisition number, after each item ordered.

Reporting directly to the assistant general storekeeper should be the general stock clerk in charge of requisitions, general foreman, section storekeepers, receiving and shipping clerks and printing department superintendent. The general stock clerk or requisition clerk, should prepare all requisitions. They should be written according to section. The general foreman will have charge of all physical conditions as regards the actual handling and storing of material as well as the general upkeep of the properties. Section storekeepers are required to inspect all materials received for their respective sections, call to the attention of the assistant general storekeeper items which are not standard, slow moving or interchangeable. The receiving clerk has charge of all material received until it is checked, unloaded and turned over to the section storekeeper. His force is divided into crews under a gang boss. The shipping clerk has charge of all shipping. The shipping crew packs and checks all material received from the various sections. He should have a daily schedule of shipping points so that full advantage may be taken of transportation facilities. The printing department superintendent should have full charge of the operation of the printing plant. He should have a practical knowledge of printing equipment, different weights of paper, methods of padding and costs of his department.

In connection with an efficient stores organization, there must be adequate space and facilities for the handling of scrap material as this is a very important phase of store work. There also should be a reclamation shop of sufficient size and equipped especially for this work.

As a part of each store organization there should be a fire squad, trained in the methods of extinguishing. This squad should be familiar with all outlets and should have a definite time allotted to drill.

Proper handling devices should be provided so that the work can be done economically.

District or Division Stores

In the preceding paragraphs of this report we have confined ourselves to the general store organization, but as many public utility companies operate over such extensive territories, it makes it necessary to install district or division stores at centrally located sectional points. As the operation of these stores differs somewhat to that of the general store, we make the following recommendations:

The location of a district or division store should be as near the center of the district it serves as possible. It should be considered a unit in itself, entirely independent from the general store but under the supervision of the general storekeeper. The usual force necessary to the efficient handling of a district store is district storekeeper, bookkeeper and one or more stock clerks. The district storekeeper should have charge of all work performed in the district store. He should place all requisitions, check all invoices, supervise all accounting, inspect and check all receipts, oversee the issues, supervise the arrangement of stock and see that the properties are kept in a neat and orderly condition.

The office routine is quite similar to that of the general store excepting that the district storekeeper deals directly with the auditor as far as the accounting for material is concerned. He should prepare a statement monthly of all debits and credits he has taken into his store accounts. The auditor should furnish him with a similar statement of debits and credits entered on the general books affecting his store, and these two statments should be reconciled. This will detect errors both of the district and the auditor, enabling adjustments to be made at the time, eliminating much checking at the time of inventory.

Particular attention should be given the issuing of material to line gangs. We recommend a requisition form, prepared to cover a period of one week or more, this form to be prepared in duplicate, one copy for the store and one for the foreman or material clerk on the gang. This will eliminate the writing of individual requisitions for each withdrawal from the store. In preparing this form it is advisable to print the description of the commonly used items, so as to simplify the filling of the orders and to make the checking more easy. The articles should be listed in alphabetical and sectional arrangements, down the center of the sheet. On one side, in the proper column, will be inserted after the item, the quantity drawn, on the other, the quantity returned. At the close of the period, the material clerk should take an actual inventory of his wagon stock, prepare a new sheet showing the different balances on hand. This should be the same as the figure shown as a balance by the storekeeper after he has balanced his previous week's sheet. This is done by inserting the quantities used on the "return to store" side of the sheet and the quantities taken from the line on the "issued" side. The difference between the "returns" and the "issues" should then equal what the material clerk shows as being on the wagon.

District storekeepers should keep the general storekeeper advised as to local conditions by sending him a monthly report showing the total stock value of material on hand and the status of all accounting and physical work. The money value of stock should be segregated under several headings as follows:

Meters	$ 3,000
Motors	800
Wire and cable	4,500
Transformers	3,100
Poles	2,000
Appliances and ranges	1,100
Miscellaneous	11,000
Total	$25,500

Annual Inventories of Material and Equipment

Report of Committee No. 11, Purchasing and Stores Section.*

THE object of an annual inventory of material and equipment of a public utility company where all material purchased is for use within the company, is to see by comparison of actual stock on hand with ledger balances, whether accurate accounting is being made of all supplies used. To avoid little or no interruptions in the receipt and disbursement of material during the time of inventory, and also as a means of obtaining an accurate count, a definite program should be outlined and followed.

This report is based on a decentralized system of stores where it is advisable to take an actual inventory once a year.

Dates of Inventory

The general storekeeper, or officer in charge of supplies, should prepare the first of each year a schedule specifying the date on which the various inventories will be taken. These dates should fall as near the end of the month as practical so that the general book balance of the auditor will reflect more nearly the actual inventory figure.

In arranging the inventory schedule, care should be exercised to see that not more than two inventories are planned for the same day, as it is necessary for a representative from both the stores and auditing department to be present and the number of men in these departments available for such work is limited.

Form of Inventory Card

The use of an inventory card has proved very satisfactory. The taking of every item is assured as the

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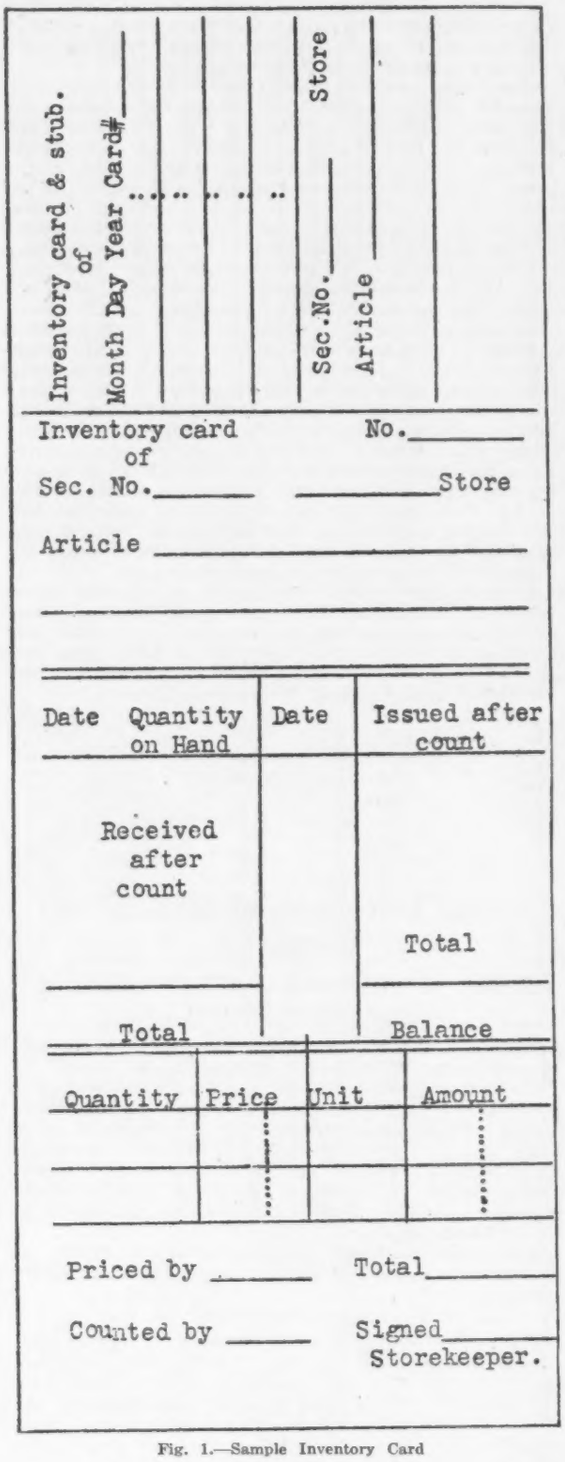

Fig. 1.—Sample Inventory Card

cards are numbered and written from the stock ledgers, and after the count has been made every number must be accounted for.

The sample card shown in Fig. 1 is suggested as very suitable. It provided for recording the following information:

1. Name of store taking inventory.
2. Date of inventory.
3. Card number.
4. Complete description of article.
5. Quantity on hand at time of count.
6. Quantity received after count.
7. Quantity issued after count.
8. Net balance on hand.
9. Quantity, unit price and money value.
10. Two or three spaces to allow pricing of material where there is more than one unit price for the same item.
11. Signature of person making the count.
12. Signature of person pricing.
13. Signature of the storekeeper.

Inventory Cards

The writing of inventory cards is a duty of the store force, and the work should be completed two weeks in advance of the count. Separate cards should be written for each item of material.

It is recommended that the numbering of cards be postponed until two or three days in advance of the inventory, due to the fact that the supply of certain classes of material shown on the stock ledgers will have been exhausted during this two week period, and there will perhaps be new items of material received which will call for additional cards. By handling in this manner the numerical and alphabetical arrangement will be kept in order.

Cards should be numbered consecutively beginning with No. 1 and the corresponding ledger page given the same number. The noun name of the material or equipment should be shown first, then the detailed description.

The party writing the card should indicate in the column marked "Unit" whether the material is to be taken by the thousand, hundred, dozen, each, weight or length. This information is of special benefit to the party counting the material.

Cards should be distributed at least one day before the count starts, and if possible placed on or near the material described. The work of placing the inventory cards should be assigned to a stock man who is thoroughly familiar with every article in stock. Employees less familiar may assist in counting the material.

Indelible pencil should be used in inserting the quantities on hand. No erasures should be made. If the recheck of an item reveals an error, a line should be drawn through the original figure and the new or correct amount shown. The person making the change should initial the card.

In recording serially numbered equipment the quantity only should appear on the face of the card. The serial numbers should be listed on the back with cost price following each number.

Care should be taken in recording the RECEIPTS and ISSUES after count in order that the net figure will be the actual quantity on hand at the time inventory is taken.

When an item is found for which there is no card, indicating the material is not posted in the stock ledgers, a card should be written and given the number next higher to the highest number in the stock ledger. A record should be kept of these cards as to number and description of material.

When the count has been completed, and all departments interested have satisfied themselves as to its correctness, the cards should be gathered up, put in consecutive order so as to be sure none are missing, and handed to the storekeeper for pricing. Cards should then be totaled, priced, extended, comptometered and posted in the stock ledgers. Cards should be kept as neat and clean as possible and should be legible as they are used in compiling the final report.

Inventory Card Stub

The sample inventory card shown in Fig. 1 has a stub attached. Ordinarily these cards should be made without a stub. Where equipment or spare parts are carried in stock from year to year the use of the stub is recommended. It is also suggested that the stub be used in cases of special items, the description being hard to get, and not commonly known by the average stockman.

The stub portion of this card should show, date of inventory, card number, section number and complete description of the material as shown on the main portion of the card. Cards should be associated with the material in the regular manner, and fastened thereto by means of tag wires. Each year that the material bearing stub tag remains in stock the new inventory card should show a reference to the original stub number and date.

As a means of associating the items shown in the stock ledger with the material bearing the inventory stub card, the word "Tag" should be stamped or written after the corresponding card number in the ledger. This eliminates the necessity of writing stubs year after year. At the completion of the count the stub portion

of the card should be torn off and left attached to the material.

Preparatory Work

The necessity for advance work in preparation for the inventory cannot be over emphasized, as upon this will largely depend the taking of the inventory accurately and quickly.

Clerical

Ledgers should be balanced at least one week before inventory. About 75 per cent of the accounts will not be re-opened and the re-balancing of the few that will have to be re-opened will be more than offset by the time saved. Keep all the current work up to date.

Comparing the ledger balances with the material on hand several times during the year is very important. This reveals any discrepancy which may be easily located and adjusted, thereby saving much time and insuring a better inventory.

Care should be taken to see that the description of the bin card or material tag is full and complete and that it corresponds with the description on the stock ledgers. This will make the work of associating the inventory cards with the material much easier. Tracers should be sent out covering all delayed billings.

Physical

Shelf stock should be arranged so as to facilitate the work of counting. Small items should be tiered in uniform even rows, which will eliminate the counting of each separate piece.

Wire should be segregated carefully. When the original tags are missing the coils should be weighed or measured and tagged with the tags arranged so they will be in plain view.

Serially numbered apparatus should be arranged so that the name and number plate can be easily seen.

As near as practical the shelf stock should conform to the alphabetical and sectional arrangement of the ledgers.

All scrap should be disposed of prior to inventory, but if this is impossible, it should be segregated as to classes, weighed or measured and tagged.

Stock should be reduced to the very lowest point consistent with good service, so as to avoid unnecessary work in counting.

When the same material is located in more than one place, a notation to this effect should be made on the bin card, showing the quantity and location of the surplus.

Partly filled containers of oil, paint or other liquids should be tagged and the contents and quantity shown.

All poles should be marked with length nails or tags and should be piled neatly and segregated as to kind and length. This will eliminate the work of measuring and tallying.

All scales and weighing machines should be listed and balanced to insure accurate weights.

Arrangements should be made to eliminate as far as possible all issues and receipts on the day the count is made.

If additional help is required, arrangements for the necessary men should be made in advance so that no delay will be experienced in commencing the work.

After the inventory has been compiled it should be checked against the entries made in the stock ledgers from the inventory cards. Special attention should be given the unit price. Many errors are made through the confusion of each, hundred and thousand prices.

If such items as nuts, washers, etc., are only carried in small quantities they should be tiered neatly and uniformly on the shelves and may be inventoried by counting the number of rows or tiers and multiplying by the number in each. For heavy stocks of such items, when the counting would be very tedious and costly, a sufficiently accurate count may be obtained by computing the actual weight on a hundred and figuring the lot by total weight, using the weight of 100 as a base. A more desirable method would be the use of the automatic counting machines which work on the principle of weight, and are figured on certain set even ratios ranging usually from 10 to 1 and 200 to 1.

Such material as bar steel and iron, when the stocks are small, should be taken by actual weight. When the quantities are large the inventory may be obtained by measuring the bars and multiplying by the weight per lineal foot. Tables showing the weight per lineal foot of the various sizes and kinds of bar steel and iron may be obtained by referring to any standard heavy hardware catalog.

It is very difficult to recommend a satisfactory way to inventory lead covered cable. On account of it being very injurious to this kind of cable to uncoil and recoil, and the work of melting and resoldering the ends quite expensive, we recommend that it be actually measured only as a last resort. The following is suggested as the most practical way to handle. Fasten securely to each reel or coil a tag showing complete description and length. When reels contain more than one piece, the reel tag should show the respective lengths and positions they occupy on the reel. On this card should be kept a careful record of all issues during the year, and at the time of inventory the net figure as reflected by the tag should be the actual quantity on hand. Should this tag be torn off and there be but little cable on the reel, the number of turns may be counted and a fairly accurate length obtained by figuring the circumference and multiplying by the number of turns. In case of a full reel where the tag is lost but the tare weight is shown, the length may be ascertained by figuring the weight per 100 ft. as based on the net weight of the reel.

An over and short report should be made of all differences of one dollar or more. Should the net overage or shortage shown on this report be very different to the net overage or shortage between the auditor's balance and the total inventory it will be evident that there has been some error made in accounting or posting to the stock ledger. If, however, the overage or shortage as shown by this report is practically the same as the auditor's difference, it will indicate that the error is in the actual handling of material. By the use of this report the items showing large differences may be picked up, and adjusted.

All work in connection with the inventory should be given preference so as to avoid confusion and error. Colored chalk or lumber crayons should be used in checking such items as pipe, cross arms, poles, guy covers, etc., as an indication that each piece has been counted.

There are two points which should be emphasized, both of which have a strong bearing on the accuracy of an inventory.

1. A monthly reconciliation should be made of each store with the balance as shown on the auditor's books. This is quite similar to a bank balance. The auditor prepares a monthly statement showing all debits and credits entered on the general books affecting a particular store. The storekeeper prepares a similar statement showing what he has debited and credited his store. These statements are checked one against the other, and all items which cannot be checked as appearing on the auditor's statement and not on the storekeepers' and vice versa, are shown on the reconciliation statement as a debit or credit as the case may be. By making this statement monthly, all errors whether made by the auditor or storekeeper are adjusted. Experience with this monthly reconciliation has demonstrated the fact that many storekeepers have been severely criticized for differences which in reality did not exist, but were the result of errors in the auditing department.

2. If we are to have good inventories, not only proper preparation must be made and instructions followed, but our storekeepers must appreciate their responsibilities as to proper accounting, ordering, disbursing and care of the thousands of material dollars of which they are custodians.

Public Relations from the Woman's Standpoint

Report of the Public Relations from the Woman's Standpoint Subcommittee, Women's Public Information Committee.*

IN addition to the subject of "informing" the women within the public utility organizations, it was felt this year that the work of the Women's Public Information Committee of the P.C.E.A. profitably could include the problem of telling the public utility story to the woman in the home.

At least one-half of the public is feminine, with a voting power equivalent to that of the male members of society and an influence which is at any rate considerable. From the standpoint of the problem of public relations, it may be remarked that the service of electricity to the home is in large measure a service to women and if it does not represent the bulk of power generated nor the greatest source of revenue to the company, it at least affects the most numerous clientele. If, again, it is the man who pays most of the bills, it is the woman in at least many cases who draws the check which goes to pay for the electricity in the home and it is out of her allowance that this item must come—in consequence it is she who notes the amount of the bill with a jealous eye and is ready to complain if she thinks the charge exhorbitant. It is further the woman who is inconvenienced if anything goes wrong with the domestic service and she who is benefited if all runs smoothly. She it is who makes the majority of purchases of electricity consuming devices which go into the home and upon her rests the decision as to how much they shall be employed. And so, although it is as a rule the husband's name which appears on the books and although the masculine voice may resound the loudest at times of public upheaval, the woman is not to be overlooked.

This factor of feminine influence in the shaping of public opinion has not been overlooked in the past. Many of the policies and much of the effort which have gone into the cementing of satisfactory public relations have been directed toward the public as a whole and have included the women as well as the men in their scope. Customer ownership, good will advertising, courtesy and a high ideal of service on the part of employees—these meet the problem of the woman as well as the man. In addition most companies have directed their attention to some extent to the women individually. But the problem of public relations has not been solved and although, of course, in the nature of life and the public, it never can be, there remain many conditions to be bettered.

This present paper is an attempt to look at the question from the woman's standpoint. It is a discussion of what has been done rather than what needs doing, to reach the woman as a factor in public relations. With the thought that the record of what one company has done with success may prove stimulating reading to another, a questionnaire covering the various phases of public relations work as specifically directed toward the woman of the community was sent out to the power companies of the Pacific Coast Electrical Association. Responses were received from the following companies:

The Southern Sierras Power Company.
San Diego Consolidated Gas & Electric Company.
San Joaquin Light & Power Corporation.
Los Angeles Gas & Electric Corporation.

*Clotilde Grunsky, McGraw-Hill Company, chairman; Bertha J. Dale, Pacific Gas and Electric Company; Helen A. Rogers, The Southern Sierras Power Company.

Fig. 1—An exhibit booth of the Pacific Gas and Electric Company which was particularly directed to the woman consumer

Coast Valleys Gas & Electric Company.
Coast Counties Gas & Electric Company.
Western States Gas & Electric Company.
The California Oregon Power Company.
Truckee River Power Company.
Pacific Gas and Electric Company.
Tucson Gas Electric Light & Power Company.
Great Western Power Company.
Desert Power & Water Company.
The Arizona Power Company.
Southern California Edison Company.

Some of the answers of especial interest are here summarized:

Home Economics Department

It was felt by the committee that the development of an adequate home economics department within the company might be of considerable value in developing good will among women customers. The answers to the questionnaires indicated that most of the companies employed one or more women demonstrators, the number varying from one to seven. Four of the companies maintained kitchens for demonstration and exhibit purposes and one reports that such a kitchen is in the process of construction. Five companies conduct cooking schools, either in conjunction with local newspapers or alone and one or two of the other companies state that they cooperate in such work with the manufacturers.

The Great Western Power Company has a demonstrating kitchen in the San Francisco office where demonstrations have been presentel in the form of electrically cooked dinners given to special groups from the various ladies' clubs, Parent Teachers Associations, domestic science instructors and the like. It is estimated that approximately 150 visitors a month come into the office to ask information and witness demonstrations by the attendant who is always on hand.

The San Joaquin Light & Power Corporation, in addition to giving demonstrations in the home, has for the past several years furnished a demonstration before the annual meeting of the Parlor Lecture Club of Fresno and to women's clubs in other parts of the territories, using all-electric appliances to make the demonstration. These were made at the request of the clubs.

Similar work of demonstrations in the home and before women's clubs is carried on by the Coast Counties Gas & Electric Company, the San Diego Consolidated Gas & Electric Company and the Pacific Gas and Electric Company.

The Southern Sierras Power Company has no demonstrators, but every range user is visited periodically by the salesmen and home demonstrations are given on request. Through this personal contact the women are also acquainted with the fact that club programs of this nature will be available if desired.

For the past four years, the Southern California Edison Company and the Los Angeles Gas & Electric Corporation, in conjunction with the electrical jobbers and mancufacturers of Los Angeles, have maintained an electrical display in the Home Economics Department of the Los Angeles Evening Express under the supervision of Mrs. Kate Brew-Vaughn, director of that department. A demonstrator is also maintained whose duty it is at all times to explain and demonstrate the various electrical appliances. Mrs. Vaughn, through her department invites women's clubs, church societies and the public in general to lectures, demonstrations, cooking schools, china painting school, talks on the care of babies, home nursing and a great many other similar activities, resulting in an average attendance of 6,000 in a month's time. Mrs. Vaughn also has carried out cooking schools in the outlying towns under the auspices of the local women's clubs. These last from one to three days and as a rule have shown to capacity houses.

Demonstrating is done in stores by the Pacific Gas and Electric Company and others have cooperated with manufacturers in pressing special campaigns.

No company reports anything which could be called a domestic science laboratory, where experiments and tests can be carried out. Such an institution would be designed not particularly to solve the problems of the electrical manufacturers, (although if improvements in electrical equipment could be suggested they would certainly increase the use of the appliance), but rather to solve the household problems which arise in connection with the use of equipment. Such laboratories are maintained by a number of the women's magazines and by one or two of the larger eastern power companies and from them emanate suggestions helpful to women in cooking, washing, cleaning and the thousand and one duties of the household. Thousands of requests for information come into the household economics department of such a magazine as Good Housekeeping every month and the data sent out by mail in response is greater than the amount of information which finds its way into the pages of the magazine.

Why should not the housewife look to the power company instead of the woman's magazine to give her information in regard to the use of her electric equipment? Such assistance would enable her to make more effective use of electricity and hence not only increase her consumption, but lead to very kindly feelings be-

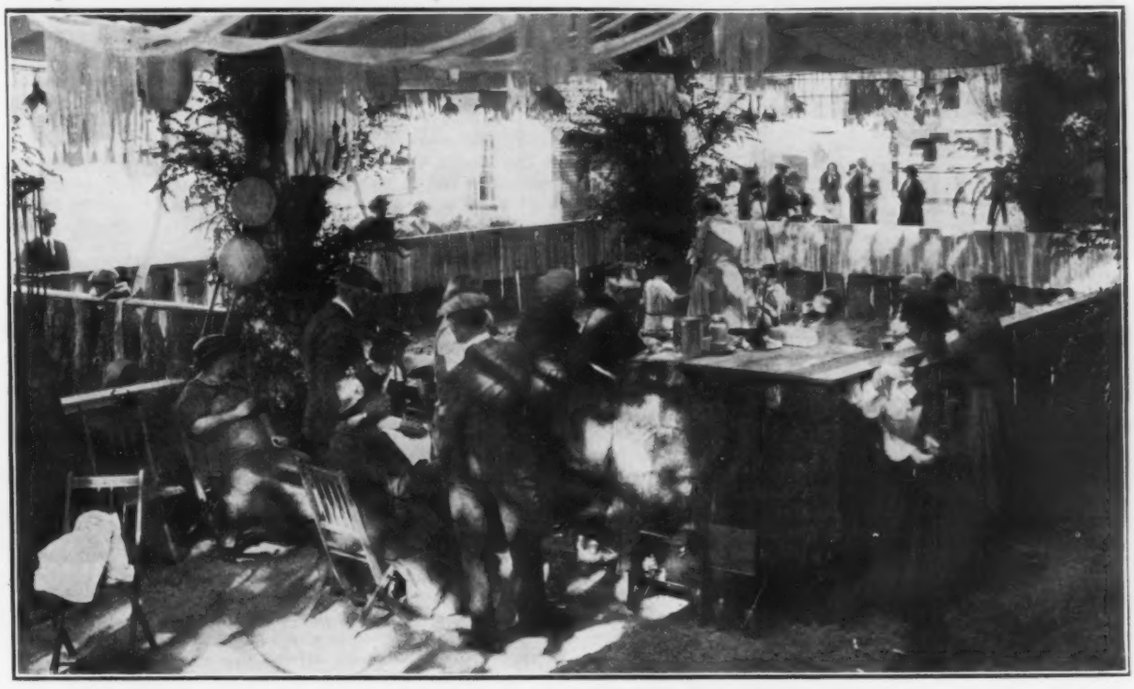

Fig. 2—The day nursery for children which was the contribution of the San Joaquin Light & Power Corporation to the Fresno Fair.

tween herself and the company. Is there not the possibility here for an information service which would be built up by means of advertising and through the personal contact of salesmen and demonstrators? The head of such a laboratory would be available for programs before women's clubs and domestic science classes in the schools, she might conduct an educational half hour over the radio, she would send out articles and written matter through channels of the press and through company publications, by mail or personal distribution. This is a suggestion which presents itself as worthy of further discussion.

Advertising and Publications

Most of the companies do a certain amount of advertising which can be classified as good will advertising and among this is usually represented the subject of electricity in the home.

One of the most interesting experiments reported in this line is a series of advertisements run by the Los Angeles Gas & Electric Corporation designed to make their service and the contact which their employees have with the public better understood. Among these are several addressed directly to women, notably those on the economical use of gas and electricity, the explanation of higher bills in summer, the problems of meter reading and the handling of meters which get out of order. These advertisements are signed by the head of the particular department in question and are accompanied by his picture so that the message has a personal ring. In addition they are couched in simple, direct language, entirely without the cant of the "be-thankful-to-the nice power-company" order.

The Pacific Gas and Electric Company and The California Oregon Power Company both submit advertisements emphasizing the convenience brought about by the use of electricity in the home.

Recipe books are given out by most of the companies in conjunction with range sales and by those who conduct cooking schools there is generally some literature distributed at this time.

The Tucson Gas, Electric Light & Power Company sends out recipes and other helpful information for housewives with their monthly bills, using material furnished by foodstuff and electric appliance advertisers in this way, as well as that from the N.E.L.A. and The Society for Electrical Development.

The California Oregon Power Company uses the small monthly bulletin "The Volt" which is sent to all consumers to carry a good will message, occasionally directing this especially to women.

Waffle iron recipes are sent out by the Valley Electrical Supply Company on postcards and are used in small folder form. In addition an occasional announcement used as an enclosure with bills or in connection with advertising calls attention to the free repair service on cords or some other such features of the store.

The Los Angeles Gas & Electric Corporation sends out a booklet descriptive of the company, containing a blank for subscriptiion to stock, and also a folder entitled "Gas Talk" which gives pointers on the efficient use of gas. This does not cover electricity, however.

This same idea is applied to both gas and electricity by the Pacific Gas and Electric Company in its "Service Manual" which is intended to give an understanding of the proper handling of the simpler problems of using modern substitutes for fuel. This is furnished any consumer on request.

The Pacific Gas and Electric Company also utilizes the small newspaper "P. G. & E. Progress" to interest and serve its women consumers. This is issued monthly and one page is devoted to "Helps for the Homemaker." Two prizes of $10 each are offered each month for the best suggestions sent in by housewives on the subject of the use or care of gas and electric equipment respectively, in addition to which a payment of $2 is made for every suggestion from a reader which is printed in the magazine. As originally planned the page was general in scope, but it has changed to cover a specific subject each time, such as "wash day problems" or "planning the home," with the idea that a better type of material will be elicited in this way. Good advice on these subjects will also be included by experts from within the company. A large number of entries is made to each contest and much interest has been shown among the women consumers of the company. The replies also indicate the apparent ignorance and the need for further information on these subjects in the average home.

Fairs and Community Occasions

Practically all of the companies large enough to carry on any activity of this kind presented exhibits at fairs and assisted whenever the event was one of importance by supplying gas and electric equipment free of charge as a form of advertising.

The Los Angeles Gas & Electric Corporation has had success with the type of booth in community industrial exhibits in which the right and wrong methods of using stoves is demonstrated, the adjustment of burners shown and other object lessons taught. Literature covering similar lessons is also distributed.

P. G. and E. Progress

Helps for the Homemaker

January Prize Winner

Make Electric Percolator Warm Milk for the Baby

Ten Dollars for Ideas

The Electrical Brownie

Messengers at Your Service

Use Your Electric Heater To Warm Breakfast Dishes

This House Clothes F

Waffle Toast Has a Lo And a Flavor All I

hing Machine Motor Does ood Job Polishing Eggs

Save Your Waxed Papers

Fig. 3—Considerable interest is shown by housekeepers in the monthly contest which is a regular feature of "P. G. & E. Progress." A sample of the electrical brownie stories for children is also shown. It is hoped to get the children to reading this feature regularly and so to carry the educational message to the parents as well as themselves

The Coast Valleys Gas & Electric Company makes a particular effort to cooperate with Farm Bureau meetings and county fairs, where the value of electricity in the home is the theme demonstrated. Demonstration booths are also a feature of the Pacific Gas and Electric Company displays and are designed to call attention to the general service of the company as well as to make sales.

An institution worthy of particular attention is the Free Day Nursery which has been a feature of the San Joaquin Light & Power Corporation's exhibit at the Fresno District Fair. This was combined with a rest room, a children's playground and an emergency hospital. In addition a miniature exhibit of the company's power development was displayed.

The playground was covered with 8-in. of clean white sand with buckets, shovels, balls, wheel barrows and a teeter-totter which kept the children busy. Two attendants were on duty here, although at time of great rush, as many as five were kept occupied. Two trained nurses took charge of the infant's department where cots and baskets were provided. A physician in charge directed the care of the little ones and in addition cared for any emergency cases. Milk was kept in an electric refrigerator heated in an electric milk warmer and regular meals furnished. Five hundred children and 117 infants were cared for during the six days of the fair. In connection with the day nursery, a first aid

station handled fifty-eight cases of various types of injuries from a sliver in the finger to serious injuries on the race track. Nine lost children turned over to the nursery by the police were restored to their parents in one day.

Three fat puppies, a cage of cooing ring doves, a bear and a combination cage of a dog and a monkey furnished entertainment for the children as well as the grown-ups and the miniature power house was always surrounded by a crowd. Anything so much needed at a country fair was bound to be appreciated and it was felt that this was a very effective builder of good will, particularly among the mothers.

Women's Clubs

Few of the companies report any effort to encourage their women employees to join women's clubs, although one or two state that they would be very glad to have their girls join if they so desire.

The San Joaquin Light & Power Corporation is now undertaking to encourage their employees in this way. The Coast Valleys Gas & Electric Company reports that nearly 100 per cent of its women employees belong to outside organizations, although dues are not paid by the company. Two companies report paying the dues of employees in women's clubs, the Pacific Gas and Electric Company and the Southern California Edison Company, both of which state that women in their employ are encouraged to join women's clubs and the dues of a reasonable number are paid.

In regard to programs available for women's clubs, it appears that such are available in the form of cooking demonstrations in the case of the large majority of the companies. A regular organized program service is provided by the Pacific Gas and Electric Company, the availability of such programs being made known to the clubs through the local divisional organizations.

In view of the importance of personal contacts in cementing friendships and the encouragement given the men of the organization to join such groups as the Rotary and other such clubs, it would seem that in general this opportunity among the women of the community had been overlooked. Practically all women's clubs have some sort of study programs and in so far as these concern household problems, or civic problems, the power company representative should have something of value to contribute. More important than any such specific benefit, however, is the friendly feeling which is passed on from the club member to the organization she represents. It would seem advisable that the women in the power company employ be encouraged to join outside organizations and so far as is appropriate, the dues of a reasonable number are paid.

A more definite system of calling the attention of club presidents and program chairmen to the availability of programs would result probably in a more general presentation of the power company story. A woman's committee, including members of the women's clubs probably could be of assistance here.

Reaching the Children

The importance of reaching the children with the electrical story has been recognized by quite a number of the companies. Viewed from the angle of the child alone, this practice has perhaps no appropriate place in this discussion. But inasmuch as the girl of the present becomes the woman and housewife of tomorrow, this is truly a form of women's public relations work. Furthermore the story told the child is carried home and there discussed, often receiving more attention than information received direct.

With the thought of taking advantage of this indirect interest, the San Joaquin Light & Power Corporation has used a series of nursery rhymes centering about the uses of electricity and attractively illustrated as part of their advertising.

Similarly, the Pacific Gas and Electric Company has run a series of short educational stories in the "P. G. & E. Progress" relating the adventures of the electrical brownie. These are illustrated and carry the story of the same characters through many adventures. Children are consistent fans and once they become interested will insist on following the "funnies" or the particular bedtime story with which they are acquainted. It is hoped to increase the attention given the publication in this way, as well as to convey lessons in electricity to parents and children alike in palatable form.

Many of the companies have contact with the children through the public schools. In San Diego a special course for girls is given in "Applied Electricity," which includes the reading of electric meters, the replacing of fuses and the repairing of cords.

Half Minutes with L. A. SERVICE
Los Angeles Gas and Electric Corporation
BETTER SERVICE ORDER
GAS
Correct, Madam!
By E. C. RAGGIO, Investigation Clerk
A LADY was waiting in my office while I went to look up a certain point on the consumers' ledger. In my absence she had been reading one of our Better Service Orders and observed on it the printed expressions "Test Meter K. O. B." and "Re-read Meter K. O. B." Upon my return she remarked, "It would be no wonder if you made mistakes if you read your meters by radio."
"K. O. B." does look like the call letters of a radio broadcasting station, no doubt; but it isn't. It is simply the office "shorthand" for "kick on bills", which in turn means a consumer's request for the investigation of a gas or electric bill.
Our Better Service Order was devised especially to facilitate the investigation of the service being rendered to consumers, and our relations with consumers. A Better Service Order is always in readiness to be used in your behalf if there is any point in connection with your service or treatment which to you is not satisfactory.
We want to give you perfect service and treatment. If we ever fail in so doing, please tell us about it.
L-A-SERVICE

Fig. 4—A sample of advertising aimed to build good will among women consumers

The Southern Sierras Power Company has conducted groups of school children through the company's office during office hours, with the idea that they would thus obtain an idea of the magnitude of the service at their command when they press an electric light button. Demonstrations are made by this company and others before the teachers of the home economics department, with the idea that the same message will later be carried to the children.

The San Joaquin Light & Power Corporation pays some attention to children in their fair exhibits. One demonstration which attracted much interest included the baking of biscuits on a toy range before an envious and admiring audience.

The recent Home Lighting Contest of course was participated in by all the power companies and offers an

example of how the home can be reached through the children of the family.

Conclusion

The woman as a rule regards electricity primarily from the standpoint of its service in the home. Her attitude toward the power company will not be unfriendly if she feels that (1) those who deal with her are courteous (2) that her bills are not exorbitant (3) her requests for service are promptly and efficiently handled. Like anyone else, if she owns some of the stock in the company; if she understands how electricity is manufactured and how the company is run; if she knows personally and likes some of the individuals which belong to the company; if the company has helped her solve her problems; she will have an active feeling of interest in its welfare. Some of the methods by which the various Pacific Coast power companies endeavor to bring about this friendly attitude have here been outlined.

CRISP ELECTRIC GINGER BISCUIT
½ cup butter.
1 cup sugar.
½ sour cream or milk.
2 eggs.
1 tablespoon ginger.
1 teaspoon soda.
1 teaspoon cinnamon.
2½ cups sifted flour.
Juice and rind (grated rind) of 1 orange
Cream butter and sugar. Add beaten eggs Sift flour, cinnamon and ginger together and add alternately with sour milk in which soda has been dissolved, to the mixture. Add orange. Drop by spoonfuls on waffle iron and bake three minutes.
VALLEY ELECTRICAL
SUPPLY CO.
FRESNO

Fig. 5—Waffle iron recipes are passed out in conjunction with programs given before women's clubs by the San Joaquin Light & Power Corporation

In addition to the work already being done, the committee would recommend a further study of the possibilities in the following fields:

1. A home economics laboratory.
2. An information service on household problems.
3. Reaching the housewife by means of the radio.
4. Encouragement of women employees to join outside clubs.
5. Further organization to present the story of electricity before women's clubs.

Talks have been given in many of the schools in their territory by the various district managers of the Southern California Edison Company and electrical motion pictures have been shown.

A composite picture of the children of stockholders run in the little publication "Edison Partners," it was felt made much good will on the part of parents. Extra copies of the group were run off on heavy paper and sent to all who had a child represented in the picture.

Activities of the Women Within the Organization

Report of the Women's Activities within the Organization Subcommittee, Women's Public Information Committee*

FOR many years the women in the organization have been very active in all lines of endeavor, although not organized as a working unit. Realizing that women's work is a vital element in the industries a movement has been inaugurated to co-ordinate the work of the women in the public utilities of the nation. Following are interesting reports of some of the work being done by our organizations:

The Southern Sierras Power Company women for many years have been carrying on educational work in connection with their Power Club organization. This consists of talks on important features of their company's work and motion pictures of educational value. Aside from this to further accident prevention, the women have organized a first-aid class composed of two teams.

It will be interesting to know that the women of the Coast Valleys Gas & Electric Company have put out their first company paper, which is in the form of a four-page bulletin giving the up-to-the-minute office news. They also have meetings once a month and have chosen for their educational course, work of the various departments. Their instructors are the department heads. This has proved very satisfactory.

The women of the Western States Gas & Electric Company are following up the same lines of educational work, going a step further by making visits to the gas plant and becoming acquainted with the manufacture of gas.

The women employees of the San Diego Consolidated Gas & Electric Company also have had the privilege of being taken through the gas plant and the electric stations and being instructed on gas production by the superintendent. In the near future, in their new building, they expect to conduct regular cooking demonstrations by electricity and gas. They expect to be privileged to hear lectures on company methods by members of the various departments.

The Pacific Gas and Electric Company women employees always have been very active through their employees' association. They have a Women's Affairs Committee in each of the sections. The chairman of the central committee is located in San Francisco and all of the activities are carried on under her guidance, although the social affairs in each section are taken care of through the local chairman and her committee. This committee looks after the welfare of the women as to proper lunch and rest rooms. The athletic work consists of swimming, basket ball and gymnasium work, and is handled by taking out membership in the Y.W.C.A. This is of great assistance in keeping the women interested in the organization. Aside from this they take an active part with the men on the Benefit and Loan Committee, visiting the sick and needy and furnishing them with many comforts. They also have accomplished much good in the way of entertaining the disabled soldiers at the Letterman General Hospital at Christmas time. The girls have also been active in all of the stock companies.

The women of the San Joaquin Light & Power Corporation and subsidiary companies—Valley Electrical Supply Company; Fresno City Water Corporation; and Midland Counties Public Service Corporation—have always been active in many lines of endeavor. They have taken part in all civic drives for all community betterment such as: movement for Y.W.C.A. building; Community Chest; and others of similar import. There are a number of individuals having memberships in the local Y.W.C.A.; Business and Professional Women's Club, and in Fresno, one of the women is a member of the W.Y.C.A. Board. In the San Joaquin Power Club, an employee organization which has a branch in every district, the women are active members, working generally on committees and hold various offices. In the Mutual Benefit Organization, which is sponsored by the Power Club, the women take an active part, a proportionate number serving on the Board of Managers. Various forms of welfare work are undertaken by individuals and departments.

The management has put on an extensive educational course under the tutorship of the various heads of departments, the meetings being held once a week at night, for a period of eight weeks. This course has been open to women and a large number have taken advantage of it. The subjects covered are as follows:

I History and policy.
II Elementary electricity.
III Finance and stock sales.
IV Regulations and rate fixing.
V Rates, rules and regulations.
VI Salesmanship.
VII Publicity and advertising.
VIII Organization and operation of departments.

One of the most recent activities of the women of this company is the organization of a luncheon club, the initial meeting of the Fresno branch being attended by more than 100. They have outlined an extensive program of social and educational interests for these affairs and expect very soon to have a club in each district. The Fresno branch has adopted an unique method of financing their club, that of securing the agency for a household cleanser which nets them a good profit. Each member of the club proves her sales ability in disposing of the goods. As a consequence, the finances of the club are assured.

* Mrs. N. G. Letchworth, San Joaquin Light & Power Corporation, chairman.

NEWS OF THE INDUSTRY

No Agreement Reached on Hetch Hetchy Power Disposal

No agreement has been reached in the matter of the temporary disposal of the output of the city of San Francisco's Moccasin Plant. The citizens' advisory committee appointed to negotiate with officials of the Pacific Gas and Electric Company (Journal of Electricity, April 15, 1925, p. 294), was unable to come to any agreement for the distribution of the power with the company, according to a report presented May 26.

The utility company offered the city $2,000,000 a year for the 420,000,000-kw-hr. output of the plant. The advisory committee proposed a plan by which the power might be distributed over the lines of the company, the power to be sold at present legal rates and bills to be collected and accounted for by the power company. The company was to receive a stipulated compensation or a fixed price per unit of power, the compensation to be determined by the California Railroad Commission.

The city's power plant is nearing completion but its transmission line ends at Newark, about 35 miles from San Francisco, and the city has no distribution system. Mayor Rolph has announced that the special committee appointed by the Board of Supervisors, headed by himself, will take the matter in hand and find a satisfactory solution.

Denver Voters Refuse Utility Franchise Renewal

At the municipal election held in Denver May 19 the people rejected by a vote of 30,842 to 15,834 the proposed franchise renewal asked by the Public Service Company of Colorado. (Journal of Electricity, May 1, 1925, p. 340.) With the exception of a few scattered precincts the average vote throughout the city was two to one against the measure.

Accompanying the franchise in defeat was a similar measure submitted by the Denver Tramway Company asking permission to establish and operate motor bus lines in the city as a supplement to street railway service. A $10,000,000 bond issue for the municipal water plant was also defeated.

With a fifty-fifty split in the selection of elective officers and with the rejection of all measures submitted on separate ballots, there is a general feeling in Denver, it is reported, that the election represented a wave of conservatism rather than extreme objection to any particular measure.

The Public Service Company's franchise in Denver still has another year to run and it is likely, though not certain, that the franchise renewal again will be requested in the meantime. One of the principal offers of the Public Service Company in the new franchise was a reduction of rates effective June 1. With the franchise defeated these will not go into effect, the subsequent saving to the company being estimated at more than a quarter of a million dollars.

Colorado River Waterworks Plan on Los Angeles Ballot

The voters of Los Angeles will be asked to vote at the municipal election to be held June 2 on a $2,000,000 bond issue "for the acquisition, construction and completion by the city of Los Angeles of a certain revenue-producing municipal improvement, to-wit: waterworks, including the acquisition of necessary lands and rights-of-way and the construction of tunnels, canals, conduits and other necessary works in connection with an aqueduct system for obtaining an additional water supply for said city and its inhabitants from the Colorado River."

This proposition, if indorsed, it is believed, will constitute the first move in the campaign of Los Angeles water and power advocates for the construction of the Bouder Canyon dam and the consequent generation of power on the Colorado River for distribution to southern California municipalities.

Puget Sound Company to Reduce Rates for Rural Service

Simultaneously with the opening of the new 40,000-hp. hydroelectric plant at Baker River about Sept. 1, of this year, the Puget Sound Power & Light Company, Seattle, will reduce its residence and commercial lighting rates throughout the territory outside of Seattle, according to A. W. Leonard, president of the company. The reduction will be one-half cent per kw-hr. applied directly to the primary rate. The aggregate saving to company customers will amount to more than $150,000 a year, company officials announce.

The rate reduction has been coupled with the completion of the Baker River project for the reason that, when electric power from that source becomes available, the expense of operating steam generating plants at many of the principal centers will no longer be necessary, and the company plans to share the savings to be effected with its customers in the form of lower rates. With the completion of new transmission lines and various interconnections effected some time ago, the Baker River electric power can be transmitted into almost every part of western Washington.

Another important factor in the reduction, the company states, is the increased use of electric service by the average residence customer, resulting largely from the use of numerous labor-saving appliances in the home.

The new rate schedules will be filed at Olympia in the near future for approval by the Washington Department of Public Works.

Guests' Entertainment Provided in Convention Plans

During the hours when business sessions are not being held, visitors to San Francisco for the forty-eighth convention of the National Electric Light Association, June 15-19, will find a wide choice of entertainment provided for them. Features for these lighter hours will include golf, tennis, dancing, cabaret entertainment, music, tours, boat trips, and especially for the ladies card parties and teas.

The annual president's reception will be held on Monday evening, June 15. It will be followed by a formal ball. Both the reception and ball will take place at the Fairmont Hotel.

Fifteen or sixteen golf courses in and adjacent to the San Francisco Bay area will be available to the delegates. The big golf days will be Friday afternoon, June 19, and Saturday, June 20, after the business sessions have been completed. Plans also are being made to enable guests arriving early to play golf on Saturday afternoon, June 13, and Sunday, June 14. The golf committee, under the chairmanship of A. F. Hockenbeamer, will maintain a booth at the Exposition Auditorium to enable those wishing to play to sign up for matches. Golf privileges will be extended throughout the duration of the convention.

Many tours and inspection trips will be available. It is planned that before and after the convention sessions, trips will be arranged to various hydroelectric properties in California, as well as a number of shorter trips to give an indication of rural electrification on the Pacific Coast and some of the latest technical developments.

Dancing and entertainment will be carried on in the various hotels and cafes for which San Francisco is noted in such a manner as not to interfere with the business program of the convention.

On Friday afternoon following the closing business session a boat trip will be held on San Francisco Bay. An electrically propelled boat of the Key System Transit Company, will be used, affording delegates the opportunity of seeing the Golden Gate, various islands in the bay and industrial developments. R. E. Fisher is chairman of the entertainment committee.

Power Resources of Blue River Surveyed.—Following a survey of the power resources of the Blue River in Colorado, about 70 miles west of Denver, E. E. Jones, hydraulic engineer of the Geological Survey, has prepared a report on the power possibilities of that river. The report states that six sites were found between Breckinridge and the mouth of the river with a capacity, with the existing flow, of 22,000 hp. for 50 per cent of the time and 12,000 hp. for 90 per cent of the time.

Tentative Program for Forty-Eighth N.E.L.A. Convention Announced

A tentative program covering the forty-eighth convention of the National Electric Light Association, to be held in San Francisco June 15-19, has been prepared by association headquarters. The program may be changed slightly prior to the convention, but in general covers the activities during the annual meeting.

The tentative arrangement is as follows:

GENERAL SESSIONS

FRANKLIN T. GRIFFITH, chairman.
J. E. DAVIDSON, vice-chairman.

First General Session

Tuesday, June 16, 9:30 a.m.
Meeting Room, Main Auditorium

Address, "Welcome to California," F. W. Richardson, Governor of California, Sacramento, Calif.

Address, President Franklin T. Griffith, Portland Electric Power Co., Portland, Ore.

Appointment, Committee on President's Address.

Report, Treasurer W. A. Jones, Henry L. Doherty & Co., New York, N. Y.

Report, Finance Committee, Jos. B. McCall, chairman, The Philadelphia Electric Co., Philadelphia, Pa.

Report, Managing Director M. H. Aylesworth.

Report, Constitution and By-Laws Committee, W. C. L. Eglin, chairman, The Pheladelphia Electric Co., Philadelphia, Pa.

Election, Constitutional Revision Committee.

Report, Public Relations National Section, M. S. Sloan, chairman, Brooklyn Edison Co., Inc., Brooklyn, N. Y.

Report, Accounting National Section, W. Paxton Little, chairman, The Niagara Falls Power Co., Niagara Falls, N. Y.

Report, Commercial National Section, W. R. Putnam, chairman, Idaho Power Co., Boise, Idaho.

Report, Technical National Section, H. P. Liversidge, chairman, The Philadelphia Electric Co., Philadelphia, Pa.

Address, Colonel William Kelly, director of engineering, National Electric Light Association.

Election, Nominating Committee.

Second General Session

Wednesday, June 17, 9:30 a.m.
Meeting Room, Main Auditorium

Announcement, Memorials Committee.

Announcement, Resolutions Committee.

Report, Educational Committee, Fred R. Jenkins, chairman, Commonwealth Edison Co., Chicago, Ill.

Report, Lamp Committee, Frank W. Smith, chairman, The United Electric Light & Power Co., New York, N. Y.

Report, Electrification of Steam Railroads Committee, Frank R. Coates, chairman, Henry L. Doherty & Co., New York, N. Y.

Address, "The Necessity of Moving On," Paul Shoup, president, Southern Pacific Railroad Co., San Francisco, Calif.

Address, Honorable W. D. B. Ainey, president, National Association of Railway and Utilities Commissioners, Harrisburg, Pa.

Address, F. A. Wilson-Lawrenson, publisher, Hearst's Atlanta Georgia, Atlanta, Ga.

Third General Session

Thursday, June 18, 9:30 a.m.
Meeting Room, Main Auditorium

Report, Prize Awards Committee, W. H. Onken, Jr., Secretary, Electrical World, New York, N. Y.

Report, Lighting Educational Committee, J. E. Davidson, chairman, Nebraska Power Co., Omaha, Neb.

Address, Miss Julia Groo, first prize winner in Home Lighting Contest, Portland, Ore.

Report, Membership Committee, Howard K. Mohr, chairman, The Philadelphia Electric Co., Philadelphia, Pa.

Report, Water Power Development Committee, W. E. Creed, chairman, Pacific Gas and Electric Co., San Francisco, Calif.

Report, Rural Electric Service Committee, G. C. Neff, chairman, Wisconsin Power, Light & Heat Co., Madison, Wis.

Report, Relation of Electricity to Agriculture Committee, E. A. White, director, Chicago, Ill.

Address, Honorable William M. Jardine, secretary, Department of Agriculture, Washington, D. C.

Address, L. J. Tabor, Master, National Grange, Columbus, Ohio.

Fourth General Session

Friday, June 19, 9:30 a.m.
Meeting Room, Main Auditorium

Report, Wiring Committee, R. S. Hale, chairman, The Edison Electric Illuminating Co., Boston, Mass.

Report, United States Chamber of Commerce National Industrial Conference Board, John W. Lieb, N.E.L.A. representative, The New York Edison Co., New York, N. Y.

Report, Rate Research Committee, Alex Dow, chairman, The Detroit Edison Co., Detroit, Mich.

Address, "What Electricity Is Doing for Women," Mrs. John D. Sherman, president, General Federation of Women's Clubs, Washington, D. C.

Report, Insurance Committee, Charles B. Scott, chairman, Bureau of Safety, Chicago, Ill.

Report, Contact Committee, Department of Commerce, George H. Harries, chairman, H. M. Byllesby & Co., Chicago, Ill.

Report, Memorials Committee, W. H. Onken, Jr., chairman, Electrical World, New York, N. Y.

Report, Committee on President's Address.

Report, Constitutional Revision Committee.

Vote, Constitutional Amendments Proposed.

Report, Resolutions Committee.

Report, Nominating Committee.

Election, Officers and Members Executive Committee.

Adjournment.

PUBLIC POLICY COMMITTEE SESSION

MARTIN J. INSULL, chairman.

Wednesday, June 17, 8:30 p.m.
Meeting Room, Main Auditorium

Organ Recital.

Session called to order.

Report, Public Policy Committee, Martin J. Insull, chairman, Middle West Utilities Co., Chicago, Ill.

Solo (artist to be announced).

Address, Honorable Herbert Hoover, secretary, Department of Commerce, Washington, D. C.

Solo (artist to be announced).

Report, Charles A. Coffin Prize Committee, Franklin T. Griffith, chairman, Portland Electric Power Co., Portland, Ore.

Award, Charles A. Coffin Medal.

Adjournment.

PUBLIC RELATIONS NATIONAL SECTION

M. S. SLOAN, chairman
H. C. ABELL, vice-chairman
E. A. BARROWS, vice-chairman
W. H. McGRATH, vice-chairman

First Session

Tuesday, June 16, 2:30 p.m.
Meeting Room, Main Auditorium

Address, Chairman, Public Relations National Section, M. S. Sloan, Brooklyn Edison Co., Inc., Brooklyn, N. Y.

Announcement, Nominating Committee.

Report, Advertising Survey Committee, Joseph B. Groce, chairman, the Edison Electric Illuminating Co., Boston, Mass.

Report, Cooperation with Educational Institutions Committee, John C. Parker, chairman, Brooklyn Edison Co., Inc., Brooklyn, N. Y.

Report, Industrial Relations Committee, Homer E. Niesz, chairman, Commonwealth Edison Co., Chicago, Ill.

Report, Manufacturers Advertising Committee, J. C. McQuiston, chairman, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

Report, Public Speaking Committee, W. S. Vivian, chairman, Middle West Utilities Co., Chicago, Ill.

Report, Uniformity of State Regulatory Laws Committee, W. W. Freeman, chairman, the Union Gas & Electric Co., Cincinnati, Ohio.

Second Session

Wednesday, June 17, 2:30 p.m.
Meeting Room, Main Auditorium

Report, Women's Public Information Committee, Miss R. E. McKee, chairman, Middle West Utilities Co., Chicago, Ill.

Discussion, led by the chairman of the Women's Public Information Committees of the Geographic Divisions.

Canadian—Mrs. L. Magnus. Eastern—Miss Clara Zillesson. East Central—Mrs. F. A. Tate. Great Lakes—Mrs. P. W. Evans. Middle West—Miss Isabelle Davie. New England—Miss Gertrude Thibodeau. North Central—Mrs. R. G. Thompson. Northwest—Mrs. L. A. McArthur. Pacific Coast—Miss Frances Emans. Rocky Mountain—Miss Inez Thompson. Southeastern—Miss Ruth Morrison. Southwestern—Mrs. Florence D. Horn.

Report, Information Bureau Organizations Committee, H. C. Abell, chairman, Electric Bond & Share Co., New York, N. Y.

Discussion, led by Charles L. Edgar, chairman, New England Bureau of Public Service Information.

Bernard J. Mullaney, director, Illinois Committee on Public Utility Information.

Discussion by the Directors of the State Public Utility Information Bureaus.

Alabama—Leon C. Bradley. Arkansas—Earle W. Hodges. Connecticut—Clarence G. Willard. Florida—R. J. Holly. Georgia—Willard Cope. Illinois—Hal M. Lytle. Indiana—John C. Mellett. Iowa—J. Carmichael.. Kansas—H. Lee Jones. Kentucky—E. F. Kelley. Louisiana-Mississippi—Hugh M. Blain. Michigan—Alfred Fischer. Missouri—J. B. Sheridan. Nebraska—Horace M. Davis. New England Div.—Samuel T. McQuarrie. New Jersey—J. S. S. Richardson. New York—F. W. Crone. North and South Carolina—S. E. Boney. Ohio—Ben. E. Ling. Oklahoma—Edward F. McKay. Oregon—W. P. Strandborg. Pennsylvania—J. S. S. Richardson. Rocky Mountain Div.—George E. Lewis. Tennessee — Ross Murphy. Texas — George McQuaid. Washington—E. H. Thomas. West Virginia—A. Bliss McCrum. Wisconsin—A. F. Herwig.

Third Session

Thursday, June 18, 2:30 p.m.
Meeting Room, Main Auditorium

Report, Nominating Committee.

Report, Customer Ownership Committee, A. Emory Wishon, chairman, San Joaquin Light & Power Corporation, Fresno, Calif.

Report, Relations with Financial Institutions Committee, M. S. Sloan, chairman, Brooklyn Edison Co., Inc., Brooklyn, N. Y.

Symposium, "Electric Light and Power Company Finance," B. C. Forbes, editor, Hearst's Publications, New York, N. Y.; Sidney Z. Mitchell, president, Electric Bond & Share Co., New York, N. Y.; Alfred L. Loomis, vice-president, Bonbright & Co., Inc., New York, N. Y.; Martin J. Insull, president, Middle West Utilities Co., Chicago, Ill.

Adjournment.

ACCOUNTING NATIONAL SECTION

W. PAXTON LITTLE, chairman.
WALTER C. LANG, vice-chairman
A. R. PATTERSON, vice-chairman
C. M. BREITINGER, vice-chairman

First Session

Tuesday, June 16, 2:30 p.m.
Meeting Room No. 4

Address, Chairman, Accounting National Section, W. Paxton Little, The Niagara Falls Power Co., Niagara Falls, N. Y.

Announcement, Nominating Committee.

Report, Budget Committee, Robert B. Grove, chairman, The United Electric Light & Power Co., New York, N. Y.

Report, Classification of Accounts and Annual Reports Committee, W. J. Meyers, chairman, The United Electric Light & Power Co., New York, N. Y.

Report, Customers' Records and Billing Methods Committee, W. H. Cassell, chairman, Consolidated Gas, Electric Light & Power Co., Baltimore, Md.

Report, Filing and Preservation of Records Committee, Franklyn Heydecke, chairman, Public Service Electric & Gas Co., Newark, N. J.

Report, Fixed Capital Records Committee, G. U. Stewart, chairman, The Philadelphia Electric Co., Philadelphia, Pa.

Report, Payroll Standardization Committee, W. J. Vega, chairman, The New York Edison Co., New York, N. Y.

Report, Purchasing and Storeroom Accounting Committee, K. C. Campbell, chairman, The Detroit Edison Co., Detroit, Mich.

Report, Security Accounting Committee, T. A. Wallace, chairman, Henry L. Doherty & Co., New York, N. Y.

Adjournment.

Second Session

Wednesday, June 17, 2:30 p.m.
Meeting Room No. 4

Report, Nominating Committee.

Address, speaker and title to be announced.

Address, "Indispensable," P. S. Arkwright, president, Georgia Railway & Power Co., Atlanta, Ga.

Address, W. R. Putnam, chairman, Commercial National Section, Idaho Power Co., Boise, Idaho.

Address, M. S. Sloan, chairman, Public Relations National Section, Brooklyn Edison Co., Inc., Brooklyn, N. Y.

Address, H. P. Liversidge, chairman, Technical National Section, The Philadelphia Electric Co., Philadelphia, Pa.

Address, "The Accountant's Relation to Rate Cases," H. M. Brundage, vice-president, The Empire State Gas & Electric Association, New York, N. Y.

Address, "Scope of Activities of the Accounting National Section," H. M. Edwards, vice-president, The New York Edison Co., New York, N. Y.

Adjournment.

COMMERCIAL NATIONAL SECTION

W. R. PUTNAM, chairman
F. D. PEMBLETON, vice-chairman
GEORGE H. JONES, vice-chairman

First Session

Tuesday, June 16, 2:30 p.m.
Meeting Room No. 3

Address, Chairman, Commercial National Section, W. R. Putnam, Idaho Power Co., Boise, Idaho.

Announcement, Nominating Committee.

Report, Industrial Lighting Committee, Joseph F. Becker, chairman, The United Electric Light & Power Co., New York, N. Y.

Report, Electric Cooking and Heating Committee, A. C. McMicken, chairman, Portland Electric Power Co., Portland, Ore.

Address, "Merchandising Electrical Appliances," Edward N. Hurley, chairman, Board of Directors, Hurley Machine Co., Chicago, Ill.

Report, Appliance Committee, Thomas W. Berger, chairman, The Philadelphia Electric Co., Philadelphia, Pa.

Second Session

Wednesday, June 17, 2:30 p.m.
Meeting Room No. 3

Report, Customer Relations Committee, F. F. Kellogg, chairman, Duquesne Light Co., Pittsburgh, Pa.

Report, Electric Refrigeration Committee, G. E. Miller, chairman, the Cleveland Electric Illuminating Co., Cleveland, Ohio.

Report, Power Committee, V. M. F. Tallman, chairman, Charles H. Tenney & Co., Boston, Mass.

Address, speaker representing Power Committee.

Third Session

Thursday, June 18, 2:30 p.m.
Meeting Room No. 3

Report, Nominating Committee.

Report, Transportation Committee, B. J. Martin, chairman, Commonwealth Edison Co., Chicago, Ill.

Report, Street and Highway Lighting Committee, E. W. Lloyd, chairman, Commonwealth Edison Co., Chicago, Ill.

Report, Lighting Committee, C. C. Munroe, chairman, the Detroit Edison Co., Detroit, Mich.

Adjournment.

TECHNICAL NATIONAL SECTION

H. P. LIVERSIDGE, chairman
C. F. HIRSHFELD, vice-chairman
L. M. KLAUBER, vice-chairman
W. K. VANDERPOEL, vice-chairman

First Session

Thursday, June 16, 2:30 p.m.
Meeting Room No. 2

Address, Chairman, Technical National Section, H. P. Liversidge, The Philadelphia Electric Co., Philadelphia, Pa.

Announcement, Nominating Committee.

Report, Accident Prevention Committee, Charles B. Scott, chairman, Bureau of Safety, Chicago, Ill.

Report, Electrical Apparatus Committee, A. A. Meyer, chairman, The Detroit Edison Co., Detroit, Mich.

Report, Hydraulic Power Committee, R. L. Hearn, chairman, The Washington Water Power Co., Spokane, Wash.

Report, Inductive Co-ordination Committee, H. S. Phelps, chairman, The Philadelphia Electric Co., Philadelphia, Pa.

Report, Meter Committee, B. Currier, chairman, The Philadelphia Electric Co., Philadelphia, Pa.

Report, Prime Movers Committee, Nicholas Stahl, chairman, Narragansett Electric Lighting Co., Providence, R. I.

Report, Overhead Systems Committee, W. G. Kelley, chairman, Commonwealth Edison Co., Chicago, Ill.

Report, Underground Systems Committee, W. H. Cole, chairman, The Edison Electric Illuminating Co., Boston, Mass.

Second Session

Wednesday, June 17, 2:30 p.m.
Meeting Room No. 2

Address, "Some Factors Affecting the Relation of Steam and Water Power in Combined Systems," Herbert A. Barre, executive engineer, Southern California Edison Co., Los Angeles, Calif.

Address, "Special Features in Western Turbine and Water Wheel Design," Ely C. Hutchinson, vice-president, The Pelton Water Wheel Co., San Francisco, Calif.

Address, speaker to be announced.

Third Session

Thursday, June 18, 2:30 p.m.
Meeting Room No. 2

Report, Nominating Committee.

Address, "The Spirit which Permeates the Service of Our Utilities," H. Birchard Taylor, vice-president, Wm. Cramp & Sons Ship and Engine Building Co., Philadelphia, Pa.

Address, "The Status of the Engineer," R. F. Pack, vice-president, National Electric Light Association, Minneapolis, Minn.

Address, "The Engineer as a Factor in Human Affairs," William F. Durand, president, American Society of Mechanical Engineers, Brooklyn, N. Y.

Adjournment.

James H. McGraw Offers Four Annual Awards for Electrical Men

To encourage individual initiative and creative thinking among electrical men, James H. McGraw has established four annual awards, three to be competed for by the men of the manufacturing, jobbing and contractor-dealer branches of the electrical industry respectively, and the fourth to be open, in addition, to the men of the central station industry.

The awards will be presented in the first three instances to that man in each field who is judged to have made the most important personal contribution to improvement or progress in the advancement of either the processes or practices or policies of manufacturing, jobbing, contracting or merchandising. A fourth award will be given to that electrical man in any of the four branches of the industry who has contributed the most valuable and useful idea for promoting cooperation between any two or more branches of the electrical industry.

No separate award is made to men of the central station industry exclusively, in deference to the fact that this field is already covered by the James H. McGraw prize and other annual awards, presented each year at the convention of the National Electric Light Association.

Each award will take the form of a bronze medal and a purse of one hundred dollars in gold. The Society for Electrical Development has been requested to act as sponsor for these awards, and appoint a committee of awards which will prepare an appropriate medal and conduct the contests.

The Manufacturers' Medal

Each year on the occasion of the meeting of either the Associated Manufacturers of Electrical Supplies or the Electric Power Club, a medal and a purse of one hundred dollars will be awarded to that employee or official of any manufacturing organization of the United States or Canada, who during the preceding year made the most constructive contribution to the commercial development of the electrical manufacturing industry through the suggestion of an idea that has been successfully applied to the product, the promotion of the market or the improvement of service. The medal and the purse will be awarded by the prize jury to that man whose submitted statement, endorsed by an executive of his organization, appeals to the judges as offering the greatest value to the electrical manufacturing industry.

The Jobbers' Medal

Each year on the occasion of the meeting of the Electrical Supply Jobbers Association, a medal and a purse of one hundred dollars will be awarded to that employee or official of any electrical supply jobbing house of the United States or Canada, who during preceding year made the most constructive contribution to the commercial development of the electrical jobbing industry, through the suggestion of an idea that has been successfully applied in the promotion of the market or the improvement of jobber service. The medal and the purse will be awarded by the prize jury to that man whose submitted statement, endorsed by an executive of his organization, appeals to the judges as offering the greatest value to the jobbing industry.

The Contractor-Dealers' Medal

Each year on the occasion of the meeting of the Association of Electragists-International, a medal and a purse of one hundred dollars will be awarded to the employee or official of any electrical contractor-dealer, contractor or dealer, of the United States or Canada, who during the preceding year made the most constructive contribution to the commercial development of the electrical contractor-dealer industry through the suggestion of an idea that has been successfully applied to raising the quality standard or adequacy of wiring installations, the promotion of the market or the improvement of service in the installation or merchandising of electrical materials, equipment or appliances. The medal and the purse will be awarded by the prize jury to that man whose submitted statement, endorsed by an executive of his company or any recognized electrical jobber with whom he deals, appeals to the judges as offering the greatest value to the electrical contractor-dealer industry.

The Medal for Cooperation

The medal for cooperation and purse of one hundred dollars will be awarded each year on the occasion of a special dinner meeting of representatives of all branches of the electrical industry to be arranged by the directors of the Society for Electrical Development at an appropriate time coinciding with a meeting of its board of directors, to that electrical man, an employee or official of any electrical manufacturing, jobbing, central station or contractor-dealer organization of the United States or Canada who during the preceding year made the most constructive contribution to the promotion of cooperation and harmony between any two or more of the different branches of the electrical industry. The medal and purse will be awarded by the prize jury to that man whose submittted statement endorsed by an executive of his organization appeals to the judges as offering an idea promising the best influence for the upbuilding of a common understanding and unity of interest among the four major groups of the electrical industry or to the improvement of the inter-relations between any two or more groups.

Purpose of Awards

Every year men of the electrical industry, through individual enterprise and personal enthusiasm, are contributing ideas that benefit the whole electrical business. These contributions are gladly and freely given in the course of the day's work. They receive no public recognition. Yet were there some established time, place and method for the reviewing of these personal achievements it would provide a graceful acknowledgment and a gratifying reward that would encourage and stimulate the entire personnel of the industry to more active thinking for the advancement of the industry and the service of the public.

To this end these awards have been instituted in the hope and belief that they may bring inspiration and added zeal, particularly to the younger employees who will be the electrical executive of tomorrow. The award is open to men of all departments of the specified branches of the industry under the conditions set forth below:

The awards have three objectives—

1. To give public recognition and reward for ideas which have been contributed to the common good by individuals of the electrical industry.
2. To give publicity to these ideas that they may have wider application and employment.
3. To stimulate and encourage electrical men to think constructively for the broad improvement of the electrical industry and to carry through the ideas that occur to them.

Nature of Competitions

The natural question is—What sort of a contribution should qualify under the McGraw Awards? This is after all not difficult to define. It may be most simply characterized, perhaps, as any new idea which any employee or official of any electrical manufacturing, jobbing or contractor-dealer organization may conceive, devise, suggest and apply to improve the methods of his branch of the industry. This may originate in any department of the business. It may be some radical benefit to stock or store keeping practice, a better way to carry out the accounting, credit or estimating function, a productive innovation in handling men or jobs, in cataloging or pricing goods, in packing, shipping or delivery, or in methods of advertising, selling or administration. The test of every case, however, will be this—Has the contribution of this idea been a constructive service to the commercial advancement of the electrical industry, in any branch or as a whole? By this it will be judged.

In the case of the medal for cooperation the award may be made for any new idea which any electrical man may conceive and introduce to improve cooperation between electrical manufacturers, jobbers, central station men and contractor-dealers, either in their personal contacts and relationships within a community or in their organized local, state, regional or national activities, wherein their interests join and harmony of purpose and policy promotes the general welfare of the industry.

Eligibility

Any employee of any house that is recognized by the judges as belonging to the branch or branches of the electrical industry competing for the award shall be eligible for this award. Each contestant must submit with his paper a letter from an executive officer of his company endorsing his statement or from some other executive recognized as of the electrical industry and in position to testify in the matter.

Form of Application

Each contestant must submit the record of his contribution in a statement presenting a full description of the idea and its application, typewritten on one side of paper only.

Judging the Awards

Entries for the four awards will be judged by juries of five men who will be appointed as follows—

For the Manufacturers' Medal—Four judges to be appointed by the Electrical Manufacturers' Council and one by Mr. McGraw.

For the Jobbers' Medal—Four judges to be appointed by the Electrical Supply Jobbers Association and one by Mr. McGraw.

For the Contractor-Dealers' Medal—Four judges to be appointed by the Association of Electragists-International and one by Mr. McGraw.

The Medal for Cooperation — Four judges to be appointed by the Society for Electrical Development from its board of directors, one each from the groups representing the four branches of the electrical industry, and one by Mr. McGraw.

In the event that no contribution submitted in any one of the contests should be considered worthy, the judges are empowered to make no presentation of that award that year.

Date of Awards

The first competition for these four McGraw Awards will close on Sept. 1, 1925. Candidates must submit their statements not later than this date, addressed to The James H. McGraw Awards, in care of the Society for Electrical Development, 522 Fifth Avenue, New York City. Subsequent awards will be presented annually at a date to be announced. The first presentations will be made as follows—

The manufacturers' medal and the purse in November at the winter meeting of either the Associated Manufacturers of Electrical Supplies, or the Electric Power Club, depending upon whether the recipient of the award is connected with the supply or apparatus end of the manufacturing industry. Subsequent awards will be presented annually at the regular summer convention of either the Associated Manufacturers of Electrical Supplies or the Electric Power Club.

The jobbers' medal and the purse in November during the winter meeting of the Electrical Supply Jobbers Association. Subsequent awards will be presented annually, at the regular summer convention of the Electrical Supply Jobbers Association.

The contractor-dealer medal and the purse in September during the fall meeting of the Association of Electragists-International. Subsequent awards will be presented annually at the regular fall convention of this association.

The medal for cooperation and the purse during the autumn at a time to be announced later coincident with the fall meeting of the directors of the Society for Electrical Development. Subsequent awards will be presented annually about the same time.

Information

Any man of the electrical industry who feels in doubt as to whether a certain idea or service rendered in the interest of either the manufacturing jobbing or contractor-dealer branch of the electrical industry or to promote cooperation between industry groups is applicable or eligible for entry for the award, is invited to communicate directly to The James H. McGraw Awards, in care of the Society for Electrical Development, 522 Fifth Avenue, New York City, where information and advice will be gladly given.

The personnel of the committee of awards, appointed by The Society for Electrical Development, is as follows: W. W. Freeman, president Union Gas & Electric Company, Cincinnati, Ohio; H. B. Crouse, president Crouse-Hinds Company, Syracuse, N. Y.; W. E. Robertson, vice-president Robertson Cataract Electric Company, Buffalo, N. Y.; L. K. Comstock, president L. K. Comstock & Company, New York; F. M. Feiker, vice-president The Society for Electrical Development; Earl E. Whitehorne, commercial editor, Electrical World.

Trophy Awarded in Los Angeles Jobbers' Bowling League

Concluding the season for the Los Angeles electrical jobbers' bowling league, the members of the league gathered at the weekly meeting of the Electric Club of that city on May 18 and presented to the Reiman Wholesale Electric Company the cup donated by Jensen's Bowling Alleys. The cup is to be a perpetual trophy. Eighteen matches, from which a possible 72 points were attainable, were played by

Silver cup won by Reiman Wholesale Electric Company team in Los Angeles jobbers' bowling league tournament

the teams entered in the league, and the winning team attained a score of 48 out of the possible 72. The winning team was made up of L. E. Clarke, J. G. Marks, E. Nellor, Ray Stanek, M. Michell and E. Ritzmiller.

Second place honors were divided by the teams of the Graham Reynolds Electric Company and the Western Light & Fixture Company with a total of 42 points won. The standing of the other teams, with number of points won is as follows: (fourth) tie between Western Electric Company and Manufacturers' Agents, 36; (sixth) Illinois Electric Company, 34; (seventh) Electric Corporation, 33; (eighth) Pacific States Electric Company, 31; (ninth) Myers Electric Supply Company, 30; (tenth) Listenwalter & Gough, 28.

The bowling league was organized by the jobbers in Los Angeles in December of last year. (Journal of Electricity, April 1, p. 267.) Nine jobbing houses entered teams, and seven manufacturers' agents combined to form the tenth team of the league. During the season two sets of prizes were awarded each week, one for high series and the other for high game.

It is the intention of J. A. Sines, Chicago Fuse Manufacturing Company, to organize a similar league next year, inviting all branches of the electrical industry to enter teams. Mr. Sines organized the jobbers' league and acted as secretary-treasurer of the organization. The matter of an all-electrical league has been discussed at the Electric Club.

Washington Utility Sells 350 Ranges in Sales Campaign

A six-weeks sales campaign on Hotpoint electric ranges recently was conducted by The Washington Water Power Company, Spokane, and, while complete returns have not yet been received, indications are that the total of electric ranges and water heaters sold will reach 350. This will bring the grand total of electric ranges installed on the lines of The Washington Water Power Company to approximately 6,500.

In appreciation of their efforts a dinner was tendered the members of the sales department of the power company by W. E. Durant, Spokane representative of the Edison Electric Appliance Company, Inc. Twenty-eight members of the power company's organization were present, including J. E. E. Royer, assistant general manager; Lewis A. Lewis, sales manager; R. B. McElroy, assistant sales manager; and J. F. Farquhar, general agent. The dinner was prepared and served in the model kitchen at the general office of the power company by Miss L. Carol Dangler, special demonstrator of the Edison Electric Appliance Company, Inc., and Miss Agnes Sweeney, home economist of the central station. Miss Dangler, who cooperated with the power company during the campaign, was presented with a traveling correspondence set by Carl Hoffman of the sales department.

Free Distribution to Be Made of Surplus Primers

The Lighting Educational Committee has decided to distribute its surplus stock of Home Lighting Primers, free of charge. These primers contain the latest information on better home lighting and can be distributed to the public, especially in districts where only a portion of the people received these Primers through their children.

Orders for any quantity can be made as long as the stock lasts and all orders will be sent express collect. Companies or persons desiring these Primers should communicate with The Lighting Educational Committee, 680 Fifth Avenue, New York City.

New Unit Added to Elko, B. C., Plant.—The East Kootenay Power Company has added another 7,500-hp. unit to its plant at Elko, B. C., bringing the total capacity of its plant up to 22,500 hp. The company has duplicated 100 miles of its 250-mile high-tension line with a steel core aluminum cable that is said to have a capacity of double the original line. A fire at the company's plant, caused by a short circuit, recently destroyed two generators.

Meetings

Registration for Convention to Start June 13

For the convenience of delegates to the N.E.L.A. convention who arrive early, the registration committee has made preparations to accept registrations on June 13 and 14 prior to the official opening of the convention. Registration booths in the San Francisco Exposition Auditorium will be open from 12 noon to 5 p.m. on June 13 and from 10 a.m. to 4 p.m. on June 14.

This early registration will be for the benefit of early arrivals and also will minimize the congestion at the booths during the registration on Monday. The committee has requested that all those who can, register on one of the days prior to the official opening of the convention.

Annual Convention Utah A.A.E. Held in Provo, May 2

The annual state convention of the Utah chapter of the American Association of Engineers was held at Provo, Utah, May 2. Approximately fifty engineers from various parts of Utah were in attendance, including many of the electrical branch of the profession.

They were welcomed to Provo by Mayor O. K. Hansen. Frank Deming, president of the Provo chapter, extended greetings and on behalf of the local members of the association bade the visitors welcome. C. J. Ulrich presided at the convention.

W. M. Green, of the U. S. Bureau of Reclamation, presented a paper on the Salt Lake Basin project. He stated that the next step in the development of this project will be the formation of associations through which the work can be carried on with success. He described some of the proposed storage and irrigation features of the project, and pointed out some of its benefits.

A survey of the development of the Bear River hydroelectric plants of the Utah Power & Light Company formed the subject of an interesting paper by J. R. Jarvis, division engineer of the Ogden district of that company. Mr. Jarvis described the company's system of equalization of stream flow and water storage, and featured in his discussion the functions of the great Bear Lake storage reservoir in providing an uninterupted supply of electric service.

Rocky Mountain N.E.L.A. Meeting Plans Being Formulated

Definite plans for the annual joint convention of the Rocky Mountain division N. E. L. A. and the Colorado Public Service Association at Glenwood Springs, Colo., Sept. 14-17, have been announced by E. A. Phinney, general manager of the Jefferson County Power & Light Company, who has been designated as general convention chairman by the heads of the two organizations.

The convention this year will be one day longer than has been the practice for over twenty years, and business sessions will be held in the morning instead of twice a day as hertofore. This arrangement, according to the chairman, will provide more time for sports and outside entertainment and at the same time will insure greater interest and attendance at the longer daily sessions.

Entertainment features which proved so popular at the convention last year are to be arranged by the committee, which will have Mr. and Mrs. John J. Cooper of Denver at its head. Other members of the entertainment committee are: G. E. Lewis, Rocky Mountain Committee on Public Utility Information; J. E. Loiseau, Public Service Company of Colorado; J. E. Moorhead, Mountain States Telephone & Telegraph Company; and B. C. J. Wheatlake, General Electric Company.

Chairmen of the other committees which have been appointed are as follows: program committee—O. A. Weller, Public Service Company of Colorado; publicity committee—F. F. McCammon, Public Service Company of Colorado; transportation committee—C. C. Johnson, Mountain States Telephone & Telegraph Company.

The convention will be held at the Hotel Colorado, as has been the practice in previous years.

COMING EVENTS

Electrical Supply Jobbers' Association—
Annual Convention—Hot Springs, Va.
June 1-6, 1925

Associated Manufacturers of Electrical Supplies—
Annual Meeting—Hot Springs, Va.
June 8-13, 1925

Electric Truck School—
Pacific Gas and Electric Company Building, San Francisco
June 8-13, 1925

Industrial Electric Heating School—
Pacific Gas and Electric Company Building, San Francisco
June 9-13, 1925

Northwest Electric Light and Power Association—Annual Convention —
Gasco Building, Portland, Ore.
June 12, 1925

Pacific Coast Electrical Association—
Annual Meeting—San Francisco, Calif.
June 15, 1925

National Electric Light Association—
Annual Convention—San Francisco, Calif.
June 15-19, 1925

Jobbers Hold Quarterly Meeting at Santa Barbara

Discussion of credit relations of the electrical jobber and dealer formed the principal part of the open meeting held in connection with the quarterly meeting of the Pacific Coast Electrical Supply Jobbers' Association held at Santa Barbara, Calif., May 7-9. The Electrical Credit Men's Association conducted parallel sessions. Closed sessions were conducted in the Hotel Arlington during the morning and afternoon hours of the three days, the open meeting being held on the evening of the last day. The meeting was opened by Rudolph Holterman, vice-president and general manager of the Fobes Supply Company, San Francisco, and chairman of the association. Mr. Holterman turned the meeting over to S. W. Murray, credit manager of the Illinois Electric Company, Los Angeles, who acted as chairman of the evening.

J. G. Marks, of the Reiman Wholesale Electric Company of Los Angeles, delivered a paper on "Credit Cheaters," during the course of which he brought out an interesting thought concerning the advisability of concentration of purchases rather than diversification. Mr. Marks' theory was that in the case of dealers placing their orders with comparatively few jobbers in larger amounts the interest and assistance of the jobber would be proportionately greater. This would work to the advantage of the dealer in case at any time he should find himself in difficulties of any nature.

Mr. Marks spoke of the advantage that had accrued to the contractor situation in Los Angeles on account of the city ruling requiring registration of contractors, a $1,000 bond and $100 annual tax. This, according to Mr. Marks, has reduced the number of contractors in that city nearly 50 per cent. The indiscriminate extension of credits is very detrimental to the industry, in fact many are now insisting upon the establishment of a rule by which no credit is granted unless the application is accompanied by a financial statement supplemented by quarterly statements thereafter. It was stated that the city of Los Angeles produces more small business failures than any other large city, a condition which better organization and cooperation would help to correct.

Fred P. Vose, secretary and treasurer of the National Electrical Credit Association of Chicago, delivered an interesting extemporaneous address in which he said, among other things, that business conditions generally were spotted, good and bad alternately. Referring to credits, he brought out the fact that the usual inquiry, How much do you owe? has been supplemented by a question equally important, How many do you owe? In his opinion better service from the jobber would result if the dealer concentrated his purchases and increased the volume. It is desirable, according to Mr. Vose, that a greater sympathetic interest should exist between the salesman and the credit man. He spoke of the advisability of the credit man making periodical trips through the territory with the salesmen by which he could familiarize himself at first hand with the conditions under which the dealer is operating.

A high tribute was paid to the so-called Milwaukee system by which, through cooperation between the jobbers and contractors, a system of auditing and accounting helps was furnished to the contractor by the jobber, bringing about better accounting methods and more accurate information for the dealer concerning his cost of doing business.

On the lighter side of the meeting, the East Indian festivities preceding the customary golf tournament met with an enthusiastic response. The auctioneer was Phil Gough of Listenwalter & Gough, Los Angeles. Newton Graham of the Graham-Reynolds Electric Company, Los Angeles, carried away the first prize with a comfortable margin to spare. T. E. Bibbins was second, Garnett Young third, Phil Gough fourth, E. P. Markee fifth, Ray W. Murphy sixth, Clarence Thompson seventh, Charles Goodman eighth, R. M. Alvord ninth, and Fred Mills tenth. R. M. Alvord acted as toastmaster at the golf dinner.